THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES, AND INDIA

The Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of the Colonies and India, and providing for their investigation, and for the collection and dissemination of scientific, technical, and commercial information relating to them.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to certain rights of usage by the Imperial Institute, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the

management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies, and India, as well as of the Colonial and India Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1, 1903.

On October 1, 1907, in virtue of an arrangement made with the Board of Trade and with the approval of the Secretary of State for India, the management of the Imperial Institute was transferred to the Secretary of State for the Colonies, subject to the responsibility of the Board of Trade under the Act of 1902. A Committee of Management of three members, one nominated by each of the three Government Departments chiefly concerned, has been appointed, and at present consists of Mr. C. A. Harris, C.B., C.M.G.; Sir Alfred Bateman, K.C.M.G.; and Colonel D. G. Pitcher (late Indian Army).

The first Director of the Imperial Institute was Sir Frederick Augustus Abel, Bart., G.C.V.O., K.C.B., F.R.S., who held the office until his death in the autumn of 1902. The present Director is Professor Wyndham Dunstan, C.M.G., M.A., LL.D., F.R.S., who was appointed in 1903.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to agriculture and to the commercial utilisation of economic products.

A Report by the Director on the Work of the Imperial Institute is presented to Parliament annually.

The following are the principal departments of the Institute:

Exhibition Galleries.—The collections of economic products, etc., illustrative of the general and commercial resources of the Dominions, Colonies, and India, are

arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute, which are open free to the public daily, except on Sundays, Good Friday, and Christmas Day, from 10 a.m. to 5 p.m. in summer, and 10 a.m. to 4 p.m. in winter.

The following British Dominions, Colonies, and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, New Zealand; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Northern Nigeria, Southern Nigeria; East Africa Protectorate, Zanzibar and Pemba; Uganda; Somaliland; the Anglo-Egyptian Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; and India.

Special arrangements are made to conduct parties from schools and institutions through the Colonial and Indian Collections for educational purposes.

A Central Stand for Publications and an Enquiry Office have been opened in the centre of the main gallery to facilitate the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, are available for gratuitous distribution or for sale. The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. Lists of the publications available for distribution or sale are pro-

vided, and the principal Colonial and Indian newspapers may be seen on application. An officer of the Institute is in attendance at this stand, which is in telephonic communication with the Departments in the main building.

In 1912 the public galleries were visited by 205,503 persons, and 17,595 Colonial and Indian publications were distributed.

Scientific and Technical Department.—The research laboratories of this Department, which occupy the second floor of the Imperial Institute, were established in order to provide for the investigation of new or little-known natural products from the Colonies and India and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the agriculture, trade, and industries of the Colonies and India.

The work of this Department is chiefly initiated by the Home and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office, whereby British representatives abroad may transmit to the Department for investigation such natural products of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Materials are first investigated in the research laboratories of the Department, and are afterwards submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal materials which have been investigated and valued commercially during recent years, and as to which full information is available.

The Scientific and Technical Department works in cooperation with the Agricultural and Mines Departments in

the Colonies, whose operations it supplements by undertaking such investigations as are of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial value of products (animal, vegetable, or mineral) which can be more efficiently conducted at home in communication with merchants and manufacturers, with a view to the local utilisation of these products or to their export.

A very large number of reports on these subjects have been made to the Governments of the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is now being issued in the Miscellaneous Series of Colonial Reports. Of these Selected Reports, four have been published: Part I. "Fibres" (Cd. 4588), Part II. "Gums and Resins" (Cd. 4971), Part III. "Foodstuffs" (Cd. 5137), Part IV. "Rubber and Gutta Percha" (Cd. 6022), whilst others are in preparation.

Mineral surveys, under the supervision of the Director of the Imperial Institute, and conducted by Surveyors selected by him, are in progress in several countries. All minerals found which are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports by the Director on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports.

African Tropical Service Course.—A course of instruction in certain specified subjects is now given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa. Instruction in the subject of tropical cultivation and pro-

ducts in this course is given by members of the Staff of the Imperial Institute.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Colonial and Indian works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, and India.

The library and reading-rooms are on the first floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced. Books and newspapers may be consulted for special purposes by permission.

Colonial Conference Rooms.—Three rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The Bhownagree corridor and rooms in connection with this hall are in the occupation of the Indian Section of the Imperial Institute, whilst the hall is available for lectures, meetings, etc.

The "Bulletin of the Imperial Institute" is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, price 2*s.* 6*d.* (annual subscription 11*s.*, including postage), and may be purchased through any bookseller or from agents in the Colonies and India. The BULLETIN contains records of the principal investigations conducted for the Colonies and India at the Imperial Institute, and

special articles chiefly relating to progress in tropical agriculture and the industrial utilisation of raw materials (animal, vegetable, and mineral).

Imperial Institute Handbooks on Tropical Resources.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute, and published by Mr. John Murray, price 5*s.* net each. The first two volumes are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, Director-General of Agriculture in Egypt, and lately Inspector of Agriculture for British West Africa; and *Cocoa*: *Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria. The third volume, entitled *Rubber, its Sources, Cultivation, and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Imperial Institute, is now in the press.

The following Societies have their offices at the Imperial Institute:

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is the promotion of the scientific and practical study of all questions connected with tropical agriculture and the development and utilisation of natural resources, especially of tropical countries. The British Section has its headquarters at the Imperial Institute. Members of the British Section are permitted to use the library and reading-rooms of the Imperial Institute, and a writing-room has been also provided for their use.

British Women's Emigration Association.—The British Women's Emigration Association has been assigned offices on the mezzanine floor, which are open daily from 10 a.m. to 4 p.m. Advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—An office has been allotted on the mezzanine floor to this Association. The principal object of the Association is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

Tropical Diseases Bureau.—Temporary office accommodation on the mezzanine floor has been provided for this Bureau, the main purpose of which is to collect information regarding tropical diseases and to distribute it as widely as possible among those who are engaged in combating such diseases.

THE IMPERIAL INSTITUTE

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African Tropical Service Course

Instructor in Tropical Cultivation and Products: S. E. CHANDLER, D.Sc. (Lond.), F.L.S.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

TOBACCOS FROM PORTUGUESE EAST AFRICA

UNTIL a few years ago the production of "bright" tobacco, the variety which is used in the manufacture of most of the pipe and Virginian cigarette tobaccos made in the United Kingdom, was confined to the southern portion of the United States. Now, however, the cultivation of this kind of tobacco has become firmly established in Nyasaland and Rhodesia, both of which countries export it to the United Kingdom. In other parts of south and south-eastern Africa very promising results have also been obtained with this kind of tobacco, notably in the Transvaal and Cape Province, and in the last few years interesting experiments with it have been made in the Territories of the Mozambique Company in Portuguese East Africa. Since 1909 a number of samples of tobacco have been received at the Imperial Institute from the London office of the Mozambique Company for examination, and a summary of the results obtained in this work is now given. These Mozambique tobaccos are of great interest in two ways. In the first place they confirm the experience already obtained in Nyasaland and Rhodesia that tobacco possessing the chief characteristics of "bright Virginia tobacco" can be produced outside the tobacco districts of the United States, and that such tobacco is readily saleable in this country. This is a matter of great importance, since it means that although the flavour and aroma of the "smoke" yielded by these African

tobaccos are slightly different from those furnished by the corresponding American products, these differences are either too slight to be perceptible to the average smoker, or are of a kind that suits his taste. The evidence available indicates that the latter is the case, since blends of African tobaccos have lately appeared on the market. The second point of interest in connection with these Mozambique tobaccos is that in the first series of experiments a great variety of tobacco seed was used, including that of typical "Virginian," cigar, and Levantine tobaccos. The produce was, however, all prepared by the methods adopted in curing typical Virginian tobaccos, and, curiously enough, though the leaves, as regards shape and size, retained the characteristics of the types from which they were derived, they all "smoked" more or less like Virginian tobaccos. The importance of this point lies in the fact that tobacco has been regarded hitherto as an almost mysteriously variable crop. It is well known, for example, that if tobacco is grown in a new country from Sumatra seed, care being taken to follow Sumatra methods of cultivation and preparation, the produce as a rule develops characteristics of its own, which clearly differentiate it from the type which served as its parent. In practice this means that every country which embarks on tobacco cultivation has to face the difficulty of popularising a new kind of tobacco. These African experiments, and especially those conducted in Mozambique, seem to show, however, that the factors which determine the variability of tobacco can be ascertained, and if they can once be determined, it should not be impossible to control them, at least to some extent. Such problems can only be solved by experimental work on the plantation and in the laboratory.

EXAMINATION OF SAMPLES

FIRST SERIES (1909)

No. 1. *Zimmer's Spanish.*—The sample consisted chiefly of medium-sized leaves of "semi-bright" Virginia type, but contained also many leaves which would be classed as "mahogany." The leaves were of coarse texture, and

measured from 11 to 19 in. in length by 4 to 8½ in. in breadth.

The tobacco was of fair burning quality, but the combustion was irregular. The ash was black.

No. 2. Long-leaf Gooch.—Virginia tobacco, of even, dark brown colour, and fairly free from blemishes. The leaves varied in size from 16 by 7½ in. to 13 by 5¼ in.

The tobacco held fire fairly well, and left a dark grey ash.

No. 3. Conqueror.—Dark Virginia tobacco, in good condition, and of fairly uniform nut-brown colour, with occasional green patches. The leaves measured from 13 by 5½ in. to 17 by 7½ in.

The sample was of fair burning quality, much resembling No. 2 in this respect, and left a dark grey ash.

No. 4. Connecticut Seed Leaf.—This consisted of leaves of "dark" Virginia type, but was very mixed, and in colour varied from "semi-bright" to "mahogany" and "dark." Many of the leaves showed green patches. The dimensions of the leaves varied from 11 by 3½ in. to 19 by 9 in.

The tobacco burnt fairly well, leaving a grey ash.

No. 5. Sumatra.—The sample, which was rather broken, consisted of leaves of "mahogany" tobacco, more even in colour than the preceding sample; but it was probably intended for a "bright" tobacco, and subsequently fermented, as there were many bright leaves, and the brown patches were of irregular distribution. The leaves varied in size from 9 by 4 in. to 13½ by 7 in.

The tobacco held fire only moderately well, and left a black ash.

No. 6. Yellow Mammoth.—The sample consisted for the most part of dull "mahogany" tobacco, but also contained "semi-bright" and "dark" leaves. The dimensions of the leaves in the sample varied from 16½ by 5¼ in. to 19 by 9 in.

The tobacco burnt only moderately well, and left a black ash.

No. 7. Lacks.—This tobacco was in fair condition, and consisted of rather dark "mahogany" leaves with a general greenish tinge. The leaves varied from 11 to 17 in. in length, and from 4 to 8½ in. in breadth.

The tobacco held fire only moderately well, and left a black ash.

No. 8. *Florida Sumatra.*—This sample consisted of leaves varying in colour from "dark" to dark "mahogany." Most of them were rather broken and somewhat streaky. In size the leaves varied from 10 by 4¾ in. to 17 by 8½ in.

The tobacco was of poor burning quality, and inferior to the preceding samples in this respect. The ash was black.

No. 9. *Vuelta Abajo.*—The sample consisted of leaves of fairly fine texture, mottled, and mostly of a greenish shade. The midribs and veins were rather heavily marked. In size the leaves varied from 8 by 3¼ in to 11½ by 6 in.

The tobacco held fire badly, and left a black ash.

No. 10. *Sumatra.*—The sample, which was in fair condition, consisted of "mahogany" leaves, somewhat unevenly shaded, with occasional dark streaks. The leaves measured from 10½ to 16 in. in length and from 5 to 9 in. in breadth.

The tobacco had fairly good burning qualities, and left a grey ash.

No. 11. *Cuban Leaf.*—The sample consisted of leaves of cigar type as regards size and shape, but had been prepared as a "pipe" tobacco. The leaves, which were in a rather broken condition, varied in colour from even nut-brown to well-marked "mahogany," and in dimensions from 8 by 2½ in. to 14 by 7 in.

The tobacco burnt and held fire fairly well, but the combustion was irregular.

No. 12. *Sweet Orinoco.*—"Mahogany" tobacco in fairly good condition, plentifully mixed with "semi-bright" leaves slightly marked with brown. The leaves in the sample varied from 13½ to 18 in. in length and from 5¼ to 8 in. in breadth.

The tobacco burnt fairly well, leaving a black ash.

No. 13. *Sumatra.*—"Mahogany" tobacco, including some very good leaves. The dimensions of the leaves in this sample varied from 14 by 6 in. to 16 by 8 in.

The tobacco held fire very well, but the combustion was irregular. The ash was dark grey.

No. 14. *Honduras.*—The sample consisted of leaves

varying from dark "mahogany" to very "dark" in colour and tinged somewhat with green. The texture was rather coarse. The leaves were of fairly uniform size, varying from 10 by 4½ in. to 14 by 7½ in.

The tobacco burnt poorly, leaving a black ash.

No. 15. *Eastern Pride.*—"Mahogany" tobacco, with many rather darker leaves. The sample was somewhat gritty, owing to sand on the leaves. Occasional green spots were noticed. The dimensions of the leaves were from 11½ by 5½ in. to 16 by 9½ in.

The tobacco held fire fairly well, leaving a light grey ash.

No. 16. *Kentucky Yellow.*—The sample, which was in fair condition, consisted of leaves varying in colour from "semi-bright" to "mahogany" and "dark." The leaves were very mixed as regards size, and varied from 13 by 6¼ in. to 17 by 8½ in.

The tobacco was fair to moderate in burning qualities. The ash was dark.

No. 17. *Smyrna.*—The sample consisted of leaves varying in colour from medium to dark brown. Many of the darker leaves were of an even nut-brown shade. The leaves were small, and on the whole fairly uniform in size; the extreme dimensions were 5½ by 3¼ in. and 10 by 5 in.

The tobacco had good burning qualities, except for the dark leaves, which held fire badly.

No. 18. *Goldfinder.*—The sample consisted of "mahogany" leaves, in fair condition, and with few actual blemishes, but varying considerably in size. The extreme dimensions were 11½ by 3½ in. and 17 by 8 in.

The tobacco was of rather poor burning quality, and held fire badly.

No. 19. *Warne.*—Rather coarse tobacco, varying in shade from dark "mahogany" to "dark." The leaves were badly prepared, and showed many spots, blotches, and tears. The dimensions of the leaves varied from 9½ by 4 in. to 16½ by 8½ in.

The tobacco held fire only moderately well, and the combustion was very irregular.

No. 20. *White Stem Orinoco.*—The sample consisted of

rather broken "mahogany" leaves, with occasional "bright" and some "dark" leaves. The tobacco was somewhat gritty, owing to sand. The leaves were very mixed in size, and varied from 9 by 3 in. to 15 by 7½ in.

The burning quality of the tobacco was only fair, and the combustion was irregular.

Samples 1, 4, 9, 10, and 17 were analysed, with the following results:

Numbers of sample	1	4	9	10	17	
					Dark leaves.	Light leaves.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	13·6	10·2	9·0	11·8	12·6	9·3
Nicotine . . .	1·9	4·1	2·4	3·4	2·3	1·5
Total nitrogen . .	1·5	2·6	1·4	2·0	1·6	1·8
Ash	10·6	8·7	8·0	7·3	6·4	8·8
The ash contained:						
Lime CaO	15·1	19·8	26·8	35·0	27·7	28·7
Magnesia MgO	13·2	10·6	11·5	13·2	14·8	15·0
Potash K_2O	23·8	17·4	12·5	15·5	15·7	18·8
Sulphuric acid SO_3	6·3	3·5	5·5	4·2	8·3	6·6
Chlorine Cl	6·9	0·7	1·1	0·7	4·1	4·2

The tobaccos were submitted to manufacturers, who valued them as follows as pipe tobaccos:

Nos. 3, 6, 12, 15: *8d.* per lb.

„ 16, 18, 19, 20: *6d.* per lb.

„ 1, 2, 4, 5, 7, 8, 9, 10, 11, 13, 14: 5¼*d.* to 6½*d.* per lb.

Sample No. 17 was grown from seed of Levantine type, but, as already stated, was prepared as a Virginian tobacco. It was submitted for valuation to manufacturers using Levantine tobacco, who stated that it had lost the characters of Levantine tobacco and had developed those of Virginian tobacco.

Generally speaking, the present samples may be regarded as very satisfactory for a first attempt at tobacco cultivation in a new locality, since they could all be sold as pipe tobaccos in the United Kingdom. The principal faults (apart from those due, as mentioned below, to inappropriate cultivation and preparation) are the rather poor burning quality of the samples and the dark colour of the ash. The analyses of the ash show that these faults are due to

insufficiency of potash and excessive amounts of sulphates and chlorides.

In spite of the fact that these tobaccos do not burn well, as a whole, their flavour and aroma are described by experts as very fair. These features, however, would be enhanced if the burning quality were improved. The faults characterising the combustion in the present samples can be remedied by the use of manure rich in potash. This is best applied in the form of plant ashes, and the use of potassium chloride and potassium sulphate for this purpose should be avoided.

Types of Tobaccos

As already mentioned commercial tobaccos may be roughly grouped into three main classes, viz. cigar types, Virginian types used for smoking mixtures, and small-leaved Levantine tobaccos. Each of these requires different methods of cultivation and preparation.

In the present collection of samples all three types of tobacco were represented, Nos. 4, 5, 8, 9, and 10, for example, being grown from cigar-leaf seed, and Nos. 3, 6, 12, 15, 16, and others from Virginian-leaf seed, whilst No. 17 was obtained from Levantine-leaf seed. All the samples, however, were grown and cured under "bright" tobacco conditions, so that all had the texture and appearance of pipe tobaccos and were suitable for use in the preparation of smoking mixtures.

Future Experiments

It is clear, from the results of the examination of these samples, that pipe tobaccos of good quality can be grown in the M'Zimbiti district. Of the samples examined, the most promising materials for pipe tobaccos were Nos. 3, 6, 12, 15, 16, 18, 19, and 20. It might be well in future trials to confine attention to about four of these, say Nos. 3, 6, 12, and 15, though in selecting a limited number of kinds for trial, regard should also be had to the yield obtained from each kind. The varieties selected should be cultivated by the methods in vogue for pipe tobaccos. In curing the tobacco, an attempt should be made to produce "bright"

and "semi-bright" tobaccos, since these are more valuable, as a rule, in the United Kingdom than the "mahogany" and "dark" types, which are prevalent in the samples now reported on.

Insect Pests

It should be noted that some of the present samples of tobacco were infected with "tobacco beetle," and had to be disinfected before they could be submitted to experts. The insect in question, which was probably introduced in this instance with the seed, affects stored tobacco, and has caused much trouble in the United States and elsewhere.

To prevent the development of this pest in future consignments, the curing barn and the warehouse in which the tobacco is to be stored should be thoroughly disinfected with carbon disulphide. For this purpose the barn and warehouse should be closed and made as airtight as possible, and open vessels containing carbon disulphide should be placed in them and left for twenty-four hours. The disinfectant should be used in the proportion of 1 lb. to 1,000 cubic feet of space. Carbon disulphide vapour is poisonous, and when mixed with air is highly inflammable and explosive. The disinfection should therefore be carried out under European supervision, and the greatest care should be taken that no light is brought near the buildings whilst disinfection is in progress, or until the whole of the disinfectant vapours have been dissipated. After the buildings have been treated with the disinfectant, all doors and windows should be opened wide and left so for at least twenty-four hours, or until the odour of carbon disulphide is no longer perceptible.

Considerable risk of loss attends any attempt to treat tobacco itself with insecticides, and it is better to avoid any risk of its being attacked by "tobacco beetle" by scrupulous care and cleanliness in the barns and warehouses.

Grading and Packing of Tobacco

In preparing experimental samples, such as those dealt with in the present report, grading is of little moment; but it should be noted that, in the preparation of commercial

tobacco for export, it is most important that leaves of about the same size and colour should be kept together. It is only by proper attention to grading of this kind, and to the elimination of discoloured or stained leaves, that the best prices can be obtained. The inclusion of variously coloured or stained leaves in a "hand," or a consignment, involves lower prices being obtained for the whole. As a rule, twenty to twenty-five leaves should be packed in each "hand," which should be tied at the base with a leaf of its own class.

It is also most important that tobacco should be packed neither too dry nor too damp. In many of the bundles now under report the inside leaves had been packed too damp, and had fermented during transit, becoming in this way much darker than the rest of the bundle. Generally, tobacco containing 11 to 12 per cent. of moisture at the time of packing carries well and does not become discoloured on storage.

SECOND SERIES (1910)

Flue-cured Virginian Tobaccos

These consisted wholly of tobaccos grown from seed of Virginian types of tobacco, and all were grown and cured on the lines usually adopted for such tobaccos.

No. 1. *Kentucky Yellow.*—Seed imported from Nyasaland 1910. Grown on virgin land.

The leaves varied in size from 6 by 13 in. to 9½ by 19 in. They were mostly "mahogany" in colour, a few being pale dull brown and a few "bright." Most of the leaves showed a few "burns."

The sample burnt fairly easily in cigarette form. The ash cohered well and was grey in colour.

No. 2. *Raglan's Conqueror.*—Origin and cultivation same as No. 1.

The leaves varied in size from 8½ by 17 in. to 11 by 22 in., but were mostly of the larger sizes. They were generally of typical "mahogany" colour, with a few "bright" leaves. A few of the leaves showed "burns."

The sample burnt well in cigarette form. The colour of the ash was light grey.

No. 3. *Conqueror.*—Seed imported from Rhodesia 1908; since grown and selected at M'Zimbiti. Land, 1910 season, manured with green crop cow-peas and cotton-seed; previous year unmanured.

The leaves varied from 7½ by 18 in. to 11 by 21 in., but were mostly of the larger sizes. They were almost entirely of rather dark "mahogany" colour. A few of the leaves showed "burns."

The sample burnt well in cigarette form. The ash cohered well and was dark grey in colour.

No. 4. *Goldfinder.*—Origin of seed and cultivation same as No. 3.

The leaves varied from 7½ by 18 in. to 9 by 21 in., but were mostly of the larger sizes. They were generally of a dull, rather dark "mahogany" colour. Most of the leaves showed a few "burns."

The sample burnt fairly well in cigarette form. The ash cohered well and was light grey in colour.

No. 5. *Gooch.*—Seed imported from Transvaal 1909; since grown from seed selected at M'Zimbiti. Land, 1910 season, manured with green crop of cow-peas and cotton-seed; previous year unmanured.

The leaves varied in size from 7½ by 16 in. to 8 by 18 in., and were of rather dull "mahogany" colour. Nearly all the leaves showed one or more "burns."

The sample burnt well in cigarette form. The ash cohered fairly well, but was flaky; it was of grey colour.

No. 6. *Lacks.*—Seed imported from Rhodesia 1908; since grown and selected at M'Zimbiti. Grown on two plots 1910, one manured with green crop cow-peas, one with cotton-seed; produce of two plots mixed; previous year unmanured.

The leaves varied in size from 6½ by 15 in. to 11 by 20 in., and were rather bright "mahogany" in colour. Many of the leaves showed numerous "burns."

The sample burnt fairly well in cigarette form. The ash cohered fairly well and was of grey colour.

No. 7. *White Burley.*—Seed imported from United States 1909; present crop grown from seed selected from M'Zimbiti 1909 crop. Land, 1910 season, manured with

green crop cow-peas and cotton-seed. Previous year not manured.

The leaves were fairly uniform in size, the average being 8 by 21 in. They were bright orange-brown in colour, with occasional darker and "mahogany" shades.

The sample burnt fairly well in cigarette form. The ash cohered well and was dark grey in colour.

No. 8. *Yellow Mammoth.*—Seed imported from Transvaal 1908; since grown from seed selected at M'Zimbiti. Land, 1910 season, manured with green crop cow-peas and cotton-seed. Previous year unmanured.

The leaves were fairly uniform in size, the average being 7 by 20 in. They were mostly "semi-bright" in colour. A few showed "burns."

The sample burnt well in cigarette form. The ash cohered well and was grey in colour.

No. 9. *Long-leaf Gooch.*—Origin and cultivation same as No. 8.

The leaves were fairly uniform in size, the average being 8½ by 19 in. They varied in colour from dull yellowish-brown to dull "mahogany." A few of the leaves showed "burns."

The sample burnt well in cigarette form. The ash cohered well and was grey in colour.

No. 10. *Eastern Pride.*—Origin of seed and cultivation same as No. 8.

The leaves varied in size from 7 by 15 in. to 10 by 21 in. In colour they ranged from bright "mahogany" to dull brown, but were mostly dark "mahogany." Most of the leaves showed one or more "burns."

The sample burnt fairly well in cigarette form. The ash cohered well, and was grey in colour, with black patches.

No. 11. *Kentucky Yellow.*—Origin of seed and cultivation same as No. 8.

The leaves varied in size from 6 by 15 in. to 9 by 20 in. They showed variation in colour from bright orange-brown to rather dull "mahogany." Most of the leaves showed a few "burns."

The sample burnt fairly well in cigarette form. The

ash cohered well, but was irregular in colour, being mostly light grey with darker patches.

No. 12. *Coolie Hybrid.*—Seed imported from United States 1909. Grown on land manured with green crop of cow-peas only.

The leaves varied in size from 7 by 15 in. to 11 by 21 in. They varied in colour from dull yellow to dark "mahogany," but were mostly bright "mahogany." Most of the leaves showed one or two "burns."

The sample burnt fairly well in cigarette form. The ash cohered well and was light grey in colour.

No. 13. *Maryland Smoking.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 5½ by 19 in. They were mostly "mahogany" in colour. A few of the leaves showed "burns."

The sample burnt fairly well in cigarette form. The ash cohered fairly well, and in colour was light grey but black at the edges.

No. 14. *Virginia Orinoco.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 6 by 20 in. They were mostly dull "mahogany" in colour. All the leaves showed one or two "burns."

The sample burnt fairly easily in cigarette form. The ash cohered well and was light grey in colour.

No. 15. *Brewer Hybrid.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 7½ by 15 in. They were bright orange-brown in colour. Most of the leaves showed "burns."

The sample burnt fairly well in cigarette form. The ash cohered well and was grey in colour.

No. 16. *Hester.*—Seed imported from Rhodesia 1908. Grown on land manured with cow-peas only.

The average size of the leaves was 10 by 20 in., a small proportion being long and narrow. They were mostly bright "mahogany" in colour. All the leaves showed one or more "burns."

The sample burnt fairly well in cigarette form. The

ash cohered well, and was in colour mainly light grey, but partly black.

No. 17. *White Stem.*—Origin of seed and cultivation same as No. 12.

The leaves were fairly uniform in size, the average being 7½ by 20 in. They were bright orange-brown to dull "mahogany" in colour. Most of the leaves showed one or two "burns."

The sample burnt fairly well in cigarette form. The ash was nearly white.

No. 18. *Bullion.*—Seed imported from Rhodesia 1908. Grown on land 1910, manured with cow-peas only.

The leaves varied in size from 4 by 15 in. to 7 by 22 in. They were mostly "mahogany" in colour. All the leaves showed one or more "burns."

The sample burnt fairly easily. The ash cohered fairly well, and varied in colour from light to dark grey.

No. 19. *Sweet Orinoco.*—Seed imported from United States 1908. Grown on land manured with cow-peas only.

The leaves were fairly uniform in size, the average being 8 by 22 in. They were mostly of a "mahogany" colour, a few being yellow. Most of the leaves showed a few "burns."

The sample burnt well in cigarette form, leaving an almost white ash.

Samples 1, 3, 5, 7, 8, 9, 11, and 19 were submitted to analysis with the following results:

Number of sample		1	3	5	7	8	9	11	19
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture		11·55	12·14	11·77	9·56	14·24	10·11	12·13	10·97
Nicotine		2·12	2·68	3·40	1·06	1·95	2·88	2·24	2·97
Total nitrogen		1·09	1·39	1·65	2·15	1·49	1·66	1·75	1·26
Ash		9·35	10·11	6·58	14·40	8·52	8·81	9·86	9·76
The ash contained:									
Lime	CaO	34·24	19·97	28·15	23·58	21·10	13·70	30·12	35·73
Magnesia	MgO	10·32	13·84	16·62	9·00	13·42	13·50	14·36	7·47
Potash	K_2O	17·88	31·73	24·16	29·29	28·22	34·82	23·04	22·30
Sulphuric acid	SO_3	2·62	1·75	4·48	2·12	2·82	2·82	2·37	2·88
Chlorine	Cl	2·49	3·86	3·03	14·32	2·83	1·16	2·25	3·13

Samples 12 to 18 were too small for commercial valuation; the remaining samples were stated by experts to be

useful tobaccos to blend with Virginia, and were valued as follows:

Nos. 1, 2: 8*d.* to 8½*d.* per lb.
" 3, 4, 8, 10: 7½*d.* to 8*d.* per lb.
" 5, 19: 7*d.* to 7½*d.* per lb.
" 6, 7, 9, 11: 6½*d.* to 7*d.* per lb.

The foregoing samples of Virginian tobacco represented, on the whole, tobaccos of very promising quality. They showed a considerable improvement on the previous samples, and this improvement is reflected in the somewhat higher valuations now quoted. The following general remarks may be made regarding them:

Type of Tobacco.—As pointed out in the previous report, it is advisable, for the preparation of flue-cured tobacco of Virginian type, to use tobacco grown from seed of types which have proved suitable for this purpose in the United States; and this plan has been adhered to in the case of these samples. As a result the samples conformed more closely than the former set with the requirements of tobacco manufacturers.

Composition.—The composition of the tobaccos was fairly satisfactory. They contained no more moisture than was necessary to keep them in good condition for transport, and the amounts of nicotine and nitrogen were not too high. The most noticeable feature was the small amount of mineral matter they contained. Tobaccos of the same type from the United States usually contain from 12 to 17 per cent. of ash. In this low percentage of ash the Mozambique tobaccos resemble those of Nyasaland (see this BULLETIN, 1909, **7**, 266). This relatively small percentage of mineral matter has the effect of making the tobaccos flame, rather than glow steadily, but the defect was not very noticeable in the present samples, probably owing to the fact that the proportion of potash in the mineral matter was high. The percentages of deleterious ash constituents, sulphates, and chlorides, were fortunately low in all cases, except in sample No. 7, which contained a large excess of chlorine. This tobacco seemed to have been grown under much the same conditions as the others, and there is no obvious explanation of the large amount of

chlorides it contained. Samples of this type of tobacco grown in future seasons at M'Zimbiti should be examined in order to ascertain whether this is a constant feature.

Grading.—It was pointed out in the previous report (p. 17) that efforts should be made to prepare the "brighter" kinds of this type of tobacco, and on the whole these samples were better than the previous set in this respect. There is, however, still considerable room for improvement, and when actual production on a commercial scale is undertaken the question of grading, so that each hand is uniform in colour, size, and quality, will need very careful consideration.

Air-cured Cigar Tobaccos

No. 20. *Zimmer's Spanish.*—Seed imported from Rhodesia, 1908. Grown on land manured with cow-peas and under shade.

The leaves varied in size from 5 by 13 in. to 8 by 21 in. Many of them were almost entirely green and unfermented; the rest varied in colour from dull orange-brown to dark brown, but nearly all showed green patches and "burns." The midribs were not too prominent.

The tobacco burnt fairly well. The ash cohered well, and was grey in colour with black patches.

It was analysed with the following results:

		Per cent.
Moisture		11·23
Nicotine		2·69
Total nitrogen		2·93
Ash		13·08
The ash contained:		
Lime	CaO	24·35
Magnesia	MgO	14·28
Potash	K_2O	36·50
Sulphuric acid	SO_3	6·56
Chlorine	Cl	8·03

The sample was valued by a firm of commercial experts at 6*d.* per lb.

No. 21. *Havana.*—Seed imported from Nyasaland, 1910. Grown on land manured with cow-peas and under shade.

The leaves had an average size of 6 by 13 in. They were medium reddish-brown to dark brown in colour, but

many showed green patches. Most of the leaves showed "burns." The midrib and ribs were not too prominent, and the texture of the leaf was fine and tough. When wetted and allowed to partially dry, the leaves became very gummy and adhered strongly together. The tobacco did not burn well. The ash cohered fairly well, and varied in colour from light grey to nearly black in places.

This sample was valued at 4*d.* per lb.

These two tobaccos were fairly satisfactory in composition and they burnt fairly well. Their defects were due (1) to too early collection and (2) to faulty preparation, and especially under-fermentation. It seems clear, from the results of the examination of the former set of Mozambique tobaccos and the present set, that the M'Zimbiti Station is best adapted to the cultivation of tobaccos of the Virginian type, with possibly Levantine tobaccos. It would therefore seem to be advisable to devote attention chiefly to these types for the present.

Levantine Tobaccos

These samples were raised from seed of Turkish, Smyrna, and similar types of tobacco, the seed being obtained from Rhodesia or the Transvaal. They were grown according to the plan usually followed for such tobaccos, but two different methods of curing were adopted. The first seven were "flue-cured" by the method generally used for "bright" Virginian tobaccos, and the remaining seven were "air-cured," but no information was supplied as to the method followed in the latter case.

Flue-cured Samples

No. 22. *Samsam.*—Seed imported from Transvaal, 1910. Grown on virgin land.

The leaves were fairly uniform in size and measured from 5 by 11 in. to 6 by 13 in. They were mostly bright yellow in colour, changing to orange-brown at the edges. The texture was thin and papery. Many of the leaves showed "burns" and mould stains. The aroma of the leaves was poor.

The sample burnt readily in cigarette form. The ash cohered moderately well, and varied in colour from pale grey to nearly black.

No. 23. *Baffra.*—Origin of seed and cultivation same as No. 22.

The leaves varied in size from 3½ by 7½ in. to 4½ by 10 in., and were mostly bright yellow in colour. They nearly all showed blemishes and "burns." The aroma was poor.

The sample burnt well in cigarette form. The ash cohered well, and was light grey tinged with brown.

No. 24. *Xanthi.*—Seed imported from Rhodesia, 1909. Grown on virgin land.

The majority of the leaves varied in size from 3 by 7 in to 4 by 8 in., the rest being larger. They were dull, slightly greenish-yellow in colour. Many of the leaves showed mould stains. The aroma was poor.

The sample burnt fairly well. The ash cohered fairly well, and was mostly white.

No. 25. *Smyrna.*—Seed imported from Rhodesia, 1908. Grown on virgin land, 1910.

The leaves varied in size from 2½ by 6 in. to 4½ by 9 in., and were mostly dull yellow in colour. They showed many blemishes. The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered well, and was light grey in colour.

No. 26. *Latakia.*—Seed imported from Transvaal, 1910. Grown on virgin land.

The leaves varied in size from 3 by 7 in. to 4 by 10 in. They were mostly dull yellow in colour, but a few showed a brownish tinge, and others were bright yellow. A few of the leaves showed "burns" and mould stains. The aroma was poor.

The sample burnt well in cigarette form. The ash cohered fairly well, and was light grey in colour.

No. 27. *Rhodesia Imported.*—Seed imported from Rhodesia, 1909. Grown on virgin land.

The leaves were fairly uniform in size, the average being 4 by 8 in. They were dull yellow with a tinge of orange, and most of them showed some blemishes. The aroma was poor.

The sample burnt well in cigarette form. The ash cohered fairly easily, and was light grey in colour.

No. 28. *Mahalla.*—Seed imported from Transvaal, 1909. Grown on virgin land.

The leaves were fairly uniform in size, the average being 4 by 10 in. In colour they were dull yellow with, in some cases, a slight brownish tint. Most of the leaves showed mould stains and "burns." The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered fairly well, and was light grey in colour.

Air-Cured Samples

No. 29. *Rhodesia Imported.*—Origin and cultivation same as No. 27.

The leaves varied in size from 2 by 5 in. to 4 by 9 in., and were of fairly uniform dull brown colour. A few of the leaves showed spots, and many of them "burns." The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered well, and was light grey in colour, excepting for a few darker patches.

No. 30. *Smyrna.*—Origin and cultivation same as No. 25.

The leaves were uniform in size, measuring 3½ by 7 in. They were medium brown in colour, and showed occasional green patches and mould stains. The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered well, and was light grey in colour.

No. 31. *Samsam.*—Origin and cultivation same as No. 22.

The leaves varied in size from 3½ by 7 in. to 4 by 11 in. They were mostly medium to dull brown in colour. Most of the leaves showed "burns" or "stains." The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered fairly satisfactorily, and was mostly light grey, but white in parts.

No. 32. *Mahalla.*—Origin and cultivation same as No. 28.

The leaves varied in size from 3½ by 8 in. to 5 by 12 in., and were mostly medium or dull brown in colour. Most of the leaves showed "burns" or "stains," and a few were mouldy. The aroma was poor.

The sample burnt fairly well in cigarette form. The ash cohered fairly well; it was irregular in colour, but was mostly light grey.

No. 33. *Baffra.*—Origin and cultivation same as No. 23.

The leaves varied in size from 2½ by 5½ in. to 4½ by 10 in., but were mostly 3½ by 8 in. They were of a medium, rather dull brown colour. Most of the leaves showed one or more "burns." The aroma was poor.

The sample burnt fairly well. The ash cohered fairly well, and was light grey in colour.

Three of the samples of Levantine tobaccos were analysed, with the following results:

Number of sample		22	26	31
		Per cent.	*Per cent.*	*Per cent.*
Moisture		11·47	12·31	9·87
Nicotine		0·26	0·83	0·20
Total nitrogen		1·05	1·42	1·24
Ash		11·42	7·38	7·71
The ash contained:				
Lime	CaO	23·55	34·71	22·32
Magnesia	MgO	14·80	13·75	11·71
Potash	K_2O	23·96	20·16	27·70
Sulphuric acid	SO_3	2·15	3·40	2·50
Chlorine	Cl	4·32	2·48	2·72

The samples were considered by experts to be suitable for the manufacture of cigarettes, and were valued as follows:

Nos. 29–33: 6*d.* to 7*d.* per lb.
Nos. 22–28: 5*d.* to 7*d.* per lb.

In composition and burning quality these tobaccos were all fairly satisfactory. Their chief defects were that they did not conform in size, and in aroma when smoked, with the corresponding types of Levantine tobaccos which appear in commerce. The first of these defects was probably due to the plants having been spaced too far apart, whilst the lack of aroma, and possibly to some extent the largeness of the leaves also, may have been due to the use of seed imported from Rhodesia or the Transvaal instead of direct from Turkey. One of the chief difficulties encountered in growing Turkish tobacco is the tendency of this type of tobacco to revert to the large leaf form, and this tendency is likely to be enhanced if seed is used from

countries where the cultivation of Turkish tobacco is not thoroughly established.

If experiments with this type of tobacco are continued it would be well to obtain supplies of seed from Turkey, and the methods of cultivation and preparation adopted should at first, at all events, be similar to those used in that country.

THIRD SERIES (1912)

This consisted wholly of Virginian types of tobacco. The samples were too small for analysis, but they were submitted to general examination and valuation with the following results:

No. 1. *Bullion.*—The leaves varied in size from 5½ by 14½ in. to 9 by 17½ in., and in colour from dull "mahogany" to dark brown. Most of the leaves showed one or more spots.

The tobacco held fire moderately well, and burnt fairly well with a pungent smoke, leaving a dark grey ash with white patches.

No. 2. *Hester.*—The leaves varied in size from 6 by 12 in. to 8 by 16 in., and in colour from typical "mahogany" to dark brown. Some of the leaves showed one or more spots.

The tobacco held fire fairly well and burnt moderately well, leaving a dark grey ash. The smoke was rather pungent, but mild in flavour and aroma.

No. 3. *Sweet Orinoco.*—The leaves varied in size from 7 by 15 in. to 9 by 17½ in., and in colour from typical "mahogany" to dark "mahogany." All the leaves showed one or more spots.

The tobacco held fire well, and burnt well, leaving a dark grey ash. The smoke was mild in flavour and aroma, and though slightly pungent, was less so than that of the "Hester" leaf.

No. 4. *Raglan's Conqueror.*—The leaves varied in size from 7 by 12½ in. to 8½ by 14½ in., and in colour from bright "mahogany" to typical "mahogany." Most of the leaves had one or more small spots.

The tobacco held fire well, and burnt well, leaving a nearly white, flocculent ash. The smoke was mild in aroma and flavour, and not unpleasantly pungent.

No. 5. *White Stem Orinoco.*—The leaves varied in size from 7 by 12 in. to 9½ by 17½ in., and in colour from bright "mahogany" to dull "mahogany." A few of the leaves showed one or more spots.

The tobacco held fire well, and burnt fairly well, leaving a white ash. The smoke was mild in aroma and flavour, but rather pungent.

No. 6. *Cooley Hybrid.*—The leaves varied in size from 8½ by 16 in. to 11½ by 20 in., and in colour from typical "mahogany" to dark "mahogany." Most of the leaves showed one or more spots.

The tobacco held fire badly, and also burnt rather badly, leaving a dark grey ash. The smoke was mild in aroma and flavour, but rather pungent.

The samples were submitted to a firm of manufacturers, who valued them as follows (January 1913):

Sample	Variety	Value in the United Kingdom. *Per lb.*
1.	Bullion	5½*d.*
2.	Hester	6*d.*
3.	Sweet Orinoco	6*d.*
4.	Raglan's Conqueror	7*d.*
5.	White Stem Orinoco	8*d.*
6.	Cooley Hybrid	5*d.*

On the whole, these tobaccos were of darker colour than the samples of the corresponding varieties examined previously. They were of fair quality, though No. 6 had poor burning properties, and all of them furnished a rather pungent smoke.

These tobaccos would be readily saleable in the United Kingdom, but better prices would be obtained for brighter tobaccos of the same type.

TOBACCO FROM PAPUA

The climate of Papua is well suited to tobacco, which is grown by the natives throughout the Territory. It has also been grown successfully at the Government Experiment Stations, but its cultivation on a commercial scale was not undertaken until 1910–11, when 15 acres were planted with cigar tobacco in the neighbourhood of the Laloki River, 14 to 15 tons of tobacco being harvested.

Two samples of cigar tobacco, stated to be grown on the Katea Plantation, have been examined at the Imperial Institute with the following results:

Havana Type.—The leaves mostly varied in size from 16½ by 9 in. to 20 by 10½ in., a small proportion being less than 9 in. wide. The colour ranged from greyish-brown to dark brown; a few of the leaves showed white spots. The leaves were in most cases thin and of fine texture, with large and prominent midribs. The tobacco held fire well, and left a grey ash.

The results of examination expressed on material as received were as follows:

		Per cent.
Moisture		9·76
Nicotine		1·44
Nitrogen		2·76
Ash		18·49
The ash contained:		
Lime	CaO	25·38
Magnesia	MgO	9·64
Potash	K_2O	25·04
Sulphates, expressed as sulphuric acid	SO_3	3·70
Chlorides, expressed as chlorine	Cl	6·13

The tobacco was submitted to two firms of experts, who agreed in the view that it did not exhibit the characteristics of true Havana leaf, and that the thick veins and dark colour would render most of it unsuitable for the outer wrappers of cigars. Both firms, however, considered the burning qualities to be fairly good, and recommended that the tobacco should be carefully cultivated under expert supervision. One of the firms estimated the value of the sample in a sound and dry condition at about 9*d.* per lb. in London.

Sumatra Type.—The leaves varied in size from 14½ by 6½ in. to 20½ by 12 in., with a small proportion of narrower leaves. The colour varied from a light, warm brown to a dull brown, the latter predominating. The individual leaves were fairly uniform in colour, except for small green or blackish patches. They were mostly thin, but in some cases coarse, and the veins and midribs were rather prominent, though less so than in the case of the preceding

sample. The tobacco burnt well, and left a dark grey ash.

The following results expressed on material as received were obtained on examination :

		Per cent.
Moisture		10·50
Nicotine		1·45
Nitrogen		2·62
Ash		17·70
The ash contained :		
Lime	CaO	20·20
Magnesia	MgO	7·79
Potash	K_2O	33·36
Sulphates, expressed as sulphuric acid	SO_3	2·85
Chlorides, expressed as chlorine	Cl	3·90

The tobacco was submitted to the same firms as the preceding sample. Both firms reported that the colour of most of the sample was too dark, and that for this reason it would be unsuitable for cigar wrappers. They considered, however, that a good marketable product could be produced by careful cultivation under proper supervision, as the tobacco was of good quality and burnt well. One of the firms valued it at about *9d.* per lb. in London, if marketed in dry and sound condition.

These tobaccos from the Katea Plantation were quite satisfactory in composition, and would be readily saleable in the United Kingdom. The defects which they showed could probably all be avoided in future by more careful cultivation, curing, fermenting, and grading. Judging from these two samples there seems to be no reason why cigar tobacco of a high grade should not be produced in Papua under expert supervision.

THE UTILISATION OF SUDAN DURA

REFERENCE has already been made in this BULLETIN (1911, **9**, 253) to the possibility of an export trade in dura grain from the Sudan to Europe, and an account was given of feeding trials carried out in Austria, with the object of comparing the feeding value of Sudan dura with that of maize for fattening oxen and for milch cows. Since that

date a series of technical trials and feeding experiments has been carried out with dura forwarded to the Imperial Institute from the Sudan, and a summary of the results is given in the following pages.

A considerable quantity of dura or "dari" is already imported into the United Kingdom, chiefly as a food for poultry, and the following table shows the quantities and values of this grain, imported from various sources during 1909–11.

	Quantity.			Value.		
	1909.	1910.	1911.	1909.	1910.	1911.
	cwt.	*cwt.*	*cwt.*	£	£	£
Russia	45,812	—	960	11,010	—	250
Turkey, European	1,144	—	3,685	310	—	977
Turkey, Asiatic	47,131	48,589	123,933	14,999	13,196	34,586
Egypt [1]	1,346	55,381	14,069	485	14,657	3,760
Persia	8,926	13,078	4,880	2,533	3,548	1,255
Other foreign countries	14,258	22,234	7,280	4,164	5,775	2,022
Total from foreign countries	118,617	139,282	154,807	33,501	37,176	42,850
Cape Province	11,327	18,524	900	2,856	4,417	317
British India	252,542	237,473	53,475	74,262	66,204	14,695
Other British possessions	5,142	9,075	1,960	1,473	2,221	520
Total from British possessions	269,011	265,072	56,335	78,591	72,842	15,532
Total	387,628	404,354	211,142	112,092	110,018	58,382

[1] *The dura imported from Egypt is probably in part Sudan dura received* via *Egypt.*

Dura is cultivated throughout the Sudan, where it forms the staple food of the people; most of the product is at present consumed locally, but an export trade has already been built up, the quantities and values of the exports for 1909–11 being shown in the following table:

	1909.	1910.	1911.
tons	22,352	32,377	17,794
£	140,156	121,139	88,913

The decrease in the amount of dura exported during 1911 was due mainly to a failure of the crop owing to insufficient rain, whilst the cultivation of the grain was forsaken to some extent for the more remunerative industries of gum collection and sesamum cultivation. The prospects of a good harvest during 1912 were very slight in many of the provinces, owing to lack of rain and prevalence of

pests, with the result that the people kept back their supplies, thus running the prices up to a very high figure. As a consequence of this it became necessary to import considerable quantities of dura, the amount imported during the first nine months of 1912 being 3,103 tons, valued at £24,547, as compared with 13 tons, valued at £62, during the corresponding period of 1911.

The following table gives the prices prevailing at some of the chief ports in the United Kingdom for maize and dura during 1912:

DURA.

Port.	Date.	Variety.	Price.
Hull	May 30	Rangoon	37*s.* per 480 lb.
Liverpool	May 10	Syrian	29*s.* 6*d.* to 31*s.* 6*d.* per 480 lb.
Bristol	May 9	Syrian	28*s.* 6*d.* to 29*s.* per 400 lb.
Bristol	May 9	Persian	24*s.* 6*d.* per 400 lb.
London	Feb. 23	Ordinary white	26*s.* per 480 lb.
London	Feb. 23	Small reddish	26*s.* per 480 lb.
London	Nov. 9	Sudan	£6 per ton.

MAIZE.

Port.	Date.	Variety.	Price.
Hull	May 30	River Plate	33*s.* 6*d.* per 480 lb.
Hull	May 30	Gal-Fox	33*s.* 6*d.* per 480 lb.
Liverpool	May 10	American mixed, old	7*s.* per 100 lb.
Liverpool	May 10	Cinquantina, old	9*s.* per 100 lb.
Liverpool	May 10	Turkish	6*s.* 9*d.* and 6*s.* 9½*d.* per 100 lb.
Liverpool	May 10	Plate, Yellow, new	7*s.* and 7*s.* 0½*d.* per 100 lb.
Bristol	May 9	Bessarabian, old	34*s.* per 480 lb.
Bristol	May 9	Gal-Fox	31*s.* 9*d.* per 480 lb.
London	Feb. 23	Odessa	26*s.* 6*d.* per 480 lb. (*ex* ship).
London	Feb. 23	Odessa	28*s.* per 480 lb. (landed).
London	Feb. 23	Mixed American	30*s.* per 480 lb. (*ex* ship).

It will be seen that, on the whole, dura fetches prices similar to those paid for maize.

The consignment of dura used in the feeding and technical trials weighed 10 tons, and was stated to represent the average quality of Sudan "Faterita" dura. It consisted of small round seeds, about ½ cm. in diameter; the testa was fairly hard and brittle, and the interior white and floury. The seeds were mostly white, but a small percentage were brown.

The dura as received contained about 2 per cent. of dirt, and a very slight amount of husk and small, undeveloped seeds.

A sample of the grain, previously freed from dirt, was analysed at the Imperial Institute with the following results:

	Per cent.
Moisture	8·45
Crude proteins	13·06
Consisting of:	
True proteins	12·98
Other nitrogenous substances	0·08
Fat	3·30
Carbohydrates (by difference)	72·45 [1]
Fibre	1·03
Ash	1·71
Nutrient ratio	1 : 6·1
Food units	113·3

[1] *Including* 62·66 *per cent. of starch, as determined by acid hydrolysis;* 0·66 *per cent. of reducing sugars, expressed as dextrose; and* 0·82 *per cent. of sugars which reduce after inversion, expressed as sucrose.*

The dura contained no alkaloids or cyanogenetic glucosides.

Technical Trials

Samples of the dura were submitted for experimental trial to starch and glucose manufacturers, and to brewers and distillers. The results obtained are summarised below.

Starch Manufacture.—A firm of starch manufacturers stated that they had succeeded with some difficulty in separating about 43 per cent. of starch from the grain, but that it was very difficult to get a clean separation. It would therefore not be easy to manufacture starch from the dura with existing plant, and the firm considered that special machinery would have to be devised for the purpose.

Two other firms who were consulted expressed the opinion that the dura would not be suitable for making starch.

Glucose Manufacture.—Trials of dura for the manufacture of glucose were made by a large firm, who reported that they could not utilise the grain, as it is not so good as maize for their purpose.

Distilling.—A firm of distillers stated that the grain could certainly be used as a source of alcohol, though its utilisation for this purpose would offer certain initial technical difficulties. They added that the price would be an important point, and that the dura would probably

have to be sold in London at not more than 15*s.* per 480 lb. in order to compete with other materials for distilling purposes.

Another firm of distillers stated that they had used dura some years ago, and that with them the choice between this grain and maize was only a matter of price.

A third firm stated that they had tried dura previously, but found it unsuitable for distilling purposes, as it produced a very inferior spirit. Another firm, who are manufacturers of silent spirit, reported that the results of laboratory experiments with the grain were decidedly encouraging, and that it was proposed to carry out a technical trial on a large scale when suitable plant was available in the firm's new factory.

Brewing.—A firm of brewers stated that for use in brewing the dura would require special preparation. They submitted a sample to a technical chemist, who stated that he had examined the grain on several previous occasions, but did not consider it a desirable or economical brewing material, adding that the percentage of fat was rather high, and that the grain did not yield a good extract.

Another firm expressed the opinion that the grain would have to be manufactured into "flakes" before it would be of any service in brewing; and they submitted it to a maker of flaked malt, who, however, after careful examination, did not consider the material to be promising.

A third brewing firm stated that they had previously examined dura, but had found that the percentage of fat present rendered it unsuitable for brewing purposes.

Another firm, after carrying out technical trials with the grain, also reported that the presence of fat was an objection to its use in brewing, but they added that this difficulty might perhaps be overcome.

Feeding Trials

A large quantity of the dura was supplied to Prof. Douglas Gilchrist, of the Agricultural Department of Durham University, in order that feeding trials might be carried out. The results of the experiments, which were designed to compare dura with maize as a food for dairy

cows, have been published in *Offerton Bulletin*, No. 4, 1913, *Education Committee, Durham County Council*, by Mr. F. P. Walker, B.Sc. (Edin.), Adviser in Agriculture at Armstrong College, Newcastle-on-Tyne.

Mr. Walker's report is as follows: Ten milch cows were selected after preliminary trials, lasting over a period of four weeks, and divided into two lots of five each.

At the end of the preliminary trials the two lots stood as follows:

	Total yield of milk in pints, per lot, per day.	Average yield of milk, per cow, per day.	Percentage of butter-fat in total daily yield of milk.	Average liveweight.
Lot I. . .	136·5	27·3	3·53	1177·4 lb.
Lot II. . .	135·5	27·1	3·48	1194·2 lb.

The actual experiment with dura was carried out in two sections. The cows were fed on certain rations for a period of eight weeks, after which the rations were reversed, and the experiment continued for a similar period under the altered conditions. In the first experiment the rations used per cow, per day, were as follows:

Lot I.	Lot II.
6 lb. Soya cake.	6 lb. Soya cake.
4 " Maize meal.	4 " Dura meal.
60 " Swedes.	60 " Swedes.
12 " Meadow hay.	12 " Meadow hay.
7 " Oat straw.	7 " Oat straw.

Nutritive ratio of above rations, 1 : 5.

From January 26 to 31 both lots received equal quantities of Egyptian cotton cake instead of soya cake, and it will be noted in Table I. that there was a considerable drop on that account in the average daily yield.

The cake and meal, with a small portion of chopped straw, were fed dry and the cows were allowed drinking water *ad lib.*

The yields of milk, the percentage of fat, and of "solids not fat," are tabulated separately, the figures given in the tables being the weekly averages. Each table shows the fluctuation from week to week at each milking. There are no very striking differences shown between the yields of milk from the two lots. The average total yield for the eight weeks was identical for both.

TABLE I.—AVERAGE QUANTITY OF MILK IN PINTS, PER LOT, PER DAY, FOR EIGHT WEEKS.

Week ending.	Lot I. (Maize meal). Morn.[1]	Noon.[1]	Even.[1]	Total.	Lot II. (Dura meal). Morn.[1]	Noon.[1]	Even.[1]	Total.
Dec. 28 . .	62·0	43·5	28·5	134·0	58·5	42·0	29·0	129·5
Jan. 4 . .	62·5	42·0	28·0	132·5	60·0	43·0	28·5	131·5
" 11 . .	63·0	40·5	28·5	132·0	60·0	41·0	28·5	129·5
" 18 . .	62·0	39·0	26·5	127·5	61·0	42·0	28·0	131·0
" 25 . .	60·0	39·5	28·0	127·5	60·5	41·0	29·0	130·5
Feb. 1 . .	56·0	36·0	26·0	118·0	57·0	39·5	28·0	124·5
" 8 . .	59·0	40·0	28·0	127·0	57·0	41·0	28·0	126·0
" 15 . .	60·5	40·0	28·0	128·5	57·0	39·5	27·5	124·0
Average per lot, per day for each of eight weeks	60·62	40·06	27·68	128·3	58·87	41·12	28·31	128·3

[1] *The times of milking were 5 a.m., 12.30 p.m., and 6.30 p.m.*

Quality of the milk.—The average percentage of butter-fat in the milk of each lot is shown in Table II. The average results are again strikingly similar, and the dura meal compares well with the maize. A point of interest as to the quality of the morning's milk of a group of ten cows is that with the maize-fed lot the milk fell fourteen times below the relative standard, while with the dura-fed cows the number of times below during the same period of eight weeks was eleven.

TABLE II.—AVERAGE PERCENTAGES OF BUTTER-FAT IN MILK FOR EACH OF EIGHT WEEKS.

Week ending.	Lot I. (Maize meal). Morn.	Noon.	Even.	Lot II. (Dura meal). Morn.	Noon.	Even.
December 28	2·9	3·8	3·8	3·1	3·8	3·8
January 4	3·1	3·8	3·9	3·0	3·8	3·9
" 11	3·1	3·6	3·6	3·1	3·9	3·7
" 18	3·0	4·0	3·7	3·0	3·7	3·6
" 25	3·0	3·8	3·6	3·0	3·7	3·6
February 1	3·2	3·5	4·0	3·3	3·8	3·7
" 8	3·0	4·0	3·9	3·1	3·9	3·9
" 15	3·1	3·7	4·1	3·0	3·6	4·0
Averages for each of eight weeks	3·05	3·77	3·82	3·07	3·77	3·77
Times milkings were under standard during eight weeks	14	—	—	11	—	—
Highest	3·5	4·7	4·8	4·6	4·3	4·6
Lowest	2·7	3·0	5·0	2·7	3·2	3·2

	Lot I.	Lot II.
Average percentage of butter-fat in total daily yield .	3·44	3·44
Total butter-fat per day (lb.)	4·41	4·42

TABLE III.—PERCENTAGES OF "SOLIDS NOT FAT" IN MILK FOR EIGHT WEEKS.

Week ending.	Lot I. (Maize meal). Morn.	Noon.	Even.	Lot II. (Dura meal). Morn.	Noon.	Even.
Dec. 28	9·0	8·9	9·2	9·1	8·9	9·3
Jan. 4	9·2	9·1	9·4	9·2	9·1	9·4
" 11	9·0	8·8	9·0	9·0	8·8	9·0
" 18	9·0	9·0	9·0	9·0	8·8	9·0
" 25	8·9	8·8	9·0	8·9	8·9	9·1
Feb. 1	8·9	9·0	9·0	8·9	9·0	9·0
" 8	8·9	8·9	9·0	8·9	9·0	9·0
" 15	8·9	8·9	9·0	8·9	8·9	9·0
Averages for eight weeks	8·97	8·92	9·07	8·98	8·92	9·08
Times milkings were under standard	—	—	—	1	—	—
Highest	9·5	9·6	9·8	9·5	9·3	9·9
Lowest	8·6	8·5	8·7	8·4	8·5	8·5

	Lot I.	Lot II.
Average percentage of "solids not fat" in total daily yield	8·98	8·98
Total solids not fat per day (lb.)	11·52	11·52

The "solids not fat" in both lots of milk were well above the standard, though on one occasion with the dura-fed lot they were just below. Having regard, therefore, to quantity and quality of milk produced in this experiment, the Sudan dura meal is as good a food for milch cows as maize meal when fed in similar quantities.

TABLE IV.—AVERAGE LIVEWEIGHT, IN LB., PER COW OF EACH LOT.

	Commencement.	January 17.	February 16.	Average gain or loss during experiment.
Lot I.	1177·4	1174·6	1195·6	+ 18·2
Lot II.	1194·2	1164·8	1197·0	+ 2·8

Liveweight of Cows.—The average liveweight of each cow in the lots is shown in Table IV. The difference in the increase per cow during the experiment is small, but shows in favour of the maize meal. It may be noted that throughout the experiment the cows milked well, and while the rations were calculated to produce a good milk flow there was no excess of food for fat production in addition, the cows throughout remaining in practically a healthy milk-producing state of flesh. The cows were

also in calf either at the commencement of the experiment or during its continuance.

As soon as the above experiment was completed, the rations, as already mentioned, were reversed. The object was to discover whether the dura would act in a similar manner as in the previous experiment. Unfortunately during this experiment barley and wheat straw had to be used instead of oat straw. All straw and hay of season 1911 was of good quality owing to the exceptionally dry season, and the cows ate the barley and wheat straw well. The results are given in the following tables. At the end of the sixteenth week the cows were still milking well, and the average yield of the two lots of cows per day for the second eight weeks was remarkably close.

Table V.—Average Quantity of Milk in Pints, per Lot, per Day, for Eight Weeks.

	Lot I. (Dura meal).				Lot II. (Maize meal).			
Week ending.	Morn.	Noon.	Even.	Total.	Morn.	Noon.	Even.	Total.
Feb. 22	60·5	40·0	26·5	127·0	56·5	40·5	26·5	123·5
" 29	60·0	40·0	27·0	127·0	57·5	40·5	28·0	126·0
March 7	58·5	40·0	28·0	126·5	54·0	39·0	27·5	120·5
" 14	58·0	38·0	26·0	122·0	54·5	38·5	25·0	118·0
" 21	57·0	36·0	25·0	118·0	55·0	37·5	25·0	117·5
" 28	55·0	35·5	25·0	115·5	53·0	37·0	24·5	114·5
April 4	55·5	34·5	25·0	115·0	53·0	36·0	23·0	112·0
" 11	54·0	32·0	23·0	109·0	52·5	34·5	23·0	110·0
Average per lot, per day, for eight weeks	57·31	37·0	25·68	120·0	54·5	37·93	25·31	117·7

Quality of the Milk.—The percentage of butter-fat in the milk of each lot in this experiment is shown in Table VI. As a rule, as the period of lactation lengthens, the quality of the milk improves. Contrary to the general rule, the quality of the milk throughout this experiment was slightly below the quality during the first experiment. A popular explanation of the fact would probably be that the substitution of barley and wheat straw for oat straw would naturally produce a less nutritious food, but the liveweight increase of the cows shows that they had more than sufficient food for milk-production, and it is a well-known fact that, excepting for a very short period,

it is impossible to materially alter the composition of the milk by the use of different foods.

The slightly inferior quality of the milk is therefore not easy to explain, but a little light may be thrown on the subject as being due perhaps to a peculiar seasonal effect, inasmuch as during the spring of 1912 several complaints were received at the Armstrong College as to the general poorness of milk from widely separated farms.

At any rate it is especially noticeable from Table VI. how low the percentage of fat was in both groups during the mornings. The average percentage for each of the eight weeks was actually below the relative 3 per cent. standard. The number of times the milk of the dura-fed cows in Lot I. was below the relative standard in the morning was twenty-seven, and twice at noon; while during a similar period for the maize-fed group the morning's milk was twenty-one times below 3 per cent. As the cows of Lot I. in the last experiment when maize-fed produced low-standard milk oftener than the dura, it shows again how, apart altogether from food, the individuality of particular cows governs the quality of the milk produced.

TABLE VI.—AVERAGE PERCENTAGES OF BUTTER-FAT IN MILK FOR EACH OF EIGHT WEEKS.

	Lot I. (Dura meal).			Lot II. (Maize meal).		
Week ending.	Morn.	Noon.	Even.	Morn.	Noon.	Even.
Feb. 22	3·0	3·7	3·9	3·0	3·8	3·9
„ 29	2·9	3·6	4·0	3·0	3·8	3·8
Mar. 7	3·0	3·6	4·0	3·0	3·6	4·0
„ 14	3·0	3·4	4·0	3·0	3·7	4·0
„ 21	2·9	3·4	3·9	2·9	3·7	3·9
„ 28	3·0	3·4	4·0	3·0	3·4	4·0
April 4	3·0	3·3	3·9	3·0	3·4	3·9
„ 11	3·0	3·5	3·9	3·0	3·6	3·9
Average for each of eight weeks	2·97	3·48	3·95	2·98	3·62	3·92
Times milkings were under the standard during eight weeks	27	2	—	21	—	—
Highest	3·4	4·1	4·6	3·3	4·3	4·6
Lowest	2·6	2·8	3·5	2·7	3·0	3·2

	Lot I.	Lot II.
Average percentage of butter-fat in total daily yield	3·33	3·39
Total butter-fat per day (lb.)	4·00	3·98

TABLE VII.—PERCENTAGES OF "SOLIDS NOT FAT" IN MILK FOR EIGHT WEEKS.

Week ending.	Lot I. (Dura meal). Morn.	Noon.	Even.	Lot II. (Maize meal). Morn.	Noon.	Even.
Feb. 22	8·9	8·9	9·0	8·9	9·0	9·0
„ 29	8·9	8·8	8·9	8·9	8·9	9·1
Mar. 7	8·8	8·8	8·8	8·8	8·8	9·0
„ 14	8·8	8·8	8·9	8·8	8·8	9·0
„ 21	8·7	8·9	8·9	8·8	8·9	9·0
„ 28	8·8	8·7	8·9	8·8	8·8	8·9
April 4	8·8	8·8	8·9	8·9	8·8	9·0
„ 11	8·8	8·8	8·8	8·8	8·6	8·9
Average for eight weeks	8·81	8·81	8·88	8·83	8·82	8·98
Times milkings were under standard	2	—	1	1	3	1
Highest	9·3	9·3	9·2	9·3	9·1	9·2
Lowest	8·3	8·5	8·2	8·4	8·2	8·3

	Lot I.	Lot II.
Average percentage of "solids not fat" in total daily yield	8·82	8·86
Total "solids not fat" per day (lb.)	10·58	10·43

The "solids not fat" were, during the experiment, above the standard, although, in sympathy with the general poorness of the milk in fat, there were three occasions on which they fell below the standard with Lot I. and five with Lot II. cows.

Liveweight of Cows.—The average liveweight of the cows is shown in the following table:

TABLE VIII.—AVERAGE LIVEWEIGHT, IN LB., PER COW OF EACH LOT.

	End of first experiment.	March 15.	April 13.	Average gain or loss during experiment.
Lot I.	1195·6	1173·2	1204·0	+ 8·4
Lot II.	1197·0	1167·6	1223·6	+ 26·6

The fluctuation in the average liveweight of the cows during this experiment is shown in Table VIII. The increase during the experiment in actual liveweight is again in favour of maize meal. So far, then, as quantity and quality of milk are concerned, in both of these experiments dura meal has equalled maize, but the greater increase in liveweight of the maize-fed cows favours maize as being the better food for beef production.

A careful examination of these results, summarised for the two experiments, which are naturally complementary to each other, will show that so far as actual yields of

milk, percentage of butter-fat and non-fatty solids are concerned, dura and maize have given exactly the same results. When, however, the increase in weight of the cows is taken into consideration, maize has shown itself to be the better food. These results confirm an experiment which was carried out in Austria with Sudan dura compared with Hungarian maize during the year 1907 (*loc. cit.*).

Summary of Results

(*a*) The chemical composition of "Sudan dura" closely resembles that of maize.

(*b*) The experiments were carried out at Offerton Hall for a period of sixteen weeks during the winter of 1911–12.

(*c*) The cows used in the experiment were selected after careful preliminary trials from a greater number.

(*d*) These cows were divided into two lots of five each.

(*e*) The rations for the two lots were identical, except that in one case "maize meal" was used, while in the other an equal quantity of "dura meal" was employed.

(*f*) For the first eight weeks Lot I. received maize meal, while Lot II. received dura meal; for the second eight weeks Lot I. received dura meal, while Lot II. received maize meal.

(*g*) The cows throughout the experiment relished their food, and the results, so far as flow of milk and quality (both as regards fat and non-fatty solids), were practically identical.

(*h*) Maize, so far as increase in liveweight of the cows was concerned, was a slightly better food than dura.

(*i*) The results certainly indicate that dairy farmers might with advantage use dura as a substitute for maize, especially in case of the former being the cheaper food per ton.

(*j*) Contrary to general experience, for some reason difficult to explain, the milk of both lots of cows was slightly inferior in quality during the later period of the trials.

A quantity of the grain was also supplied to the South

Eastern Agricultural College at Wye, where it was tested as a feeding stuff for both cattle and sheep, with the following results:

Milch-cows.—Twenty cows were fed with dura meal as a preliminary trial, but some of them did not appear to relish it unless it was mixed with other feeding stuffs. Those cows which ate the dura meal readily were fed with it in increasing quantities for six weeks, without any noticeable effect on their condition. The quantity of milk was not affected, and the only important results observed were a deepening of the colour of the butter made from the milk and a lowering of its melting-point when the amount of dura meal fed to the cows was increased beyond a certain point. These circumstances, however, would be advantageous in winter, when the foodstuffs commonly used render the butter pale and hard.

Sheep.—In this case the dura was cracked or "kibbled" instead of being ground into meal, and was readily eaten in this form by the sheep. The rather brittle nature of the cracked grain makes it very satisfactory as a food for sheep, and it would perhaps be specially useful for fattening the animals in winter.

General Conclusions

Three independent series of feeding trials have now been carried out in Europe with Sudan dura, and the results show that this grain is a satisfactory feeding stuff, that it is about equal in value to the better-known feeding stuff maize, and that it can be substituted for the latter without disadvantage. The results of the technical trials recorded above indicate that dura grain could probably be substituted for maize in the manufacture of certain kinds of spirit. These two uses are probably sufficient to account for all the Sudan dura that can be exported for the next few years, even if the harvests are good.

In the brewing industry and in the manufacture of starch and glucose the use of dura in place of maize presents certain technical difficulties which can probably be overcome, and which are only to be expected when attempts are made to utilise a comparatively new product

in a highly technical industry already using well-known materials obtainable in large quantities and of uniform quality.

CAMPHOR OIL AND CRUDE CAMPHOR FROM THE FEDERATED MALAY STATES

THE samples of camphor oil and crude camphor which are the subject of this report were forwarded to the Imperial Institute from Kuala Lumpur in September 1912. They were stated to represent materials obtained in the distillation of camphor from plants grown on the experimental plantations of the Agricultural Department.

Camphor Oil

This sample consisted of a pale yellow, cloudy oil containing a large amount of crystalline deposit, and possessing a mild camphoraceous odour.

The camphor in the oil was separated by cooling to $-10°$ C., and was then filtered off and thoroughly pressed. The quantity of camphor thus obtained amounted to 19·3 per cent. by weight of the original oil.

The oil from which the camphor had been removed possessed a mild, rather pleasant, slightly camphoraceous odour. It had the following constants:

Specific gravity at $\frac{15° C.}{15° C.}$	0·913
Optical rotation in 100 mm. tube at 18° C.	$+41° 1'$

The oil was found to contain no safrole. This is apparently accounted for by the fact that it was distilled from the prunings of young trees (see *Bulletin* No. 15, 1912, of the Federated Malay States Department of Agriculture). According to *Der Pflanzer* (1906, **2**, 333), a specimen of camphor oil distilled in German East Africa from the leaves and twigs of trees one to two and a half years old was reported to contain no safrole.

The oil was submitted for valuation to commercial experts in England and in Germany. The English expert stated that it was difficult to value this oil accurately, but

that if free from camphor it should be worth over 7½*d.* or 8*d.* per lb. in London (November 1912).

The German firm stated that they could not assign a definite value to the oil, as they do not use camphor oils containing no safrole, but they considered that it might possibly be worth about 30*s.* per cwt. delivered in Europe (November 1912).

Japanese camphor oil as marketed at the present time is practically free from camphor, which is extracted before shipment, and it is chiefly of value on account of the safrole it contains. As this camphor oil from the Federated Malay States does not contain any safrole, it cannot compete with the Japanese product.

Crude Camphor

This sample consisted of very pale brown crystals possessing the characteristic odour of camphor.

On pressing to remove oil and moisture the material lost 11 to 12 per cent. of its weight, indicating that it contained 88 to 89 per cent. of camphor. This proportion compares favourably with the percentage recorded for crude camphor from Japan and Formosa.

The sample of crude camphor and the clean camphor obtained from it by pressing were optically examined with the following results :

	Specific rotation.
Crude camphor as received	$+40° 50'$
,, ,, after pressing	$+42° 20'$
Camphor obtained by dissolving the crude camphor in benzene and recrystallising	$+41° 25'$

It may be added that the camphor separated from the preceding sample of camphor oil by cooling the oil to $-10°$ C. had a specific rotation of $+42° 20'$.

These specific rotations agree fairly well with those usually recorded for refined camphor, which vary between 41° and 44°.

The crude camphor was submitted to a firm of commercial experts, who reported that it appeared to be very similar in quality to Chinese "leaf" camphor, which is

occasionally put on the market in small quantities. They considered that the material would realise £6 to £6 5*s.* per cwt. in London (November 1912), with the better quality of Japanese monopoly B. camphor at £7 2*s.* 6*d.* per cwt.

The results of this investigation indicate that the sample of camphor is of satisfactory quality, and would be readily saleable as crude camphor in the United Kingdom.

The camphor oil as received at the Imperial Institute contained nearly one-fifth of its weight of camphor, and this should be separated, if possible, before the oil is exported. The oil also differs from Japanese camphor oil in containing no safrole, and for this reason its value can only be determined by further investigation.

OIL OF *EUCALYPTUS CITRIODORA* FROM MAURITIUS

Two samples of *E. citriodora* oil from Mauritius were received recently at the Imperial Institute for examination. Both samples consisted of pale yellow oil with the strong characteristic odour of citronella. They were examined, with the results given in the following table, which also includes the constants of commercial *E. citriodora* oil.

	Sample No. 1.	Sample No. 2.	Oil of *E. citriodora* according to Gildemeister and Hoffman.
Specific gravity at $\frac{15° C.}{15° C.}$	0·877	0·879	0·870 to 0·905
Optical rotation in 100 mm. tube at 21° C.	+0° 4′	+ 1° 16′	(Specific rotation up to + 2°)
Acetylisable constituents, *per cent.*	81·1	87·1	—
Solubility in 70 per cent. alcohol	Soluble in 3 or more vols.	Soluble in 2·6 or more vols.	Soluble in 4 to 5 vols.

These samples possessed the usual characteristics of *E. citriodora* oil; they were of satisfactory quality, and

similar oil would be readily saleable in the United Kingdom. Sample No. 2 was superior to No. 1, since it contained a larger proportion of the "acetylisable constituents" to which the characteristic odour is due.

The oil was submitted to several firms of commercial experts, who reported on it as follows:

(1) A firm of wholesale druggists stated that there is a fair demand for this oil at 5*s.* to 5*s.* 6*d.* per lb. (November 1912).

(2) A German firm of distillers reported that the oil resembles the *E. citriodora* oil imported from Australia which is usually sold at about 4*s.* 6*d.* per lb. in London.

(3) A firm of brokers in London considered that they could dispose of a few tons of the oil annually, if it could be offered at not more than 2*s.* 6*d.* per lb., ex warehouse (December 1912).

(4) A large firm of soap-makers stated that *E. citriodora* oil was being sold by several London merchants at 3*s.* 10*d.* to 5*s.* per lb. (November 1912), but that for their own purposes this would be too high a price. They considered, however, that they would probably be able to use the oil in fairly large quantities if they could buy it at about 2*s.* per lb.

(5) A London dealer in essential oils stated that he would be glad to receive consignments of this oil for sale, adding that the current value (January 1913) for the best quality was about 4*s.* per lb., but that he had sometimes purchased the oil at as low a price as 2*s.* 2*d.* per lb.

The reason for the considerable variation in the price quoted by different firms for this oil is that the best qualities of *E. citriodora* oil now find a limited use for certain special purposes at prices varying from 4*s.* to 5*s.* per lb. This, however, forms a very restricted market, which could be easily overstocked. From the enquiries made in the course of the present investigation it seems clear that oil of the quality represented by these samples would be suitable for these purposes, and it was recommended that a small consignment of the oil should be forwarded for experimental sale in London.

Apart from this special use, *E. citriodora* oil would be very largely used for perfuming soaps if it could be marketed in the United Kingdom at from 2*s*. to 2*s*. 6*d*. per lb., and the quotations of this order given above represent about the price which soap-makers are prepared to pay for large quantities of the oil.

MARJORAM OIL FROM CYPRUS

In previous numbers of this Bulletin (1906, **4**, 296; 1908, **6**, 208; 1911, **9**, 308, 388), principally in connection with the origanum oil of Cyprus, attention has been directed to the confusion that at present exists regarding the botanical origin of the various oils that appear in commerce as "origanum" oils. This confusion appears to be mainly due to the fact that in many cases chemists who have examined the commercial oils have not taken the precaution of comparing the oil they examined with oil from a well-authenticated specimen of the plant from which the commercial oil was supposed to have been prepared. But the trouble is also in part due to the difficulty experienced on the botanical side in identifying some of the plants which yield these oils. As an instance of this kind it may be mentioned that the plant which yields the origanum oil of Cyprus is referred by Dr. Stapf, of the Royal Gardens, Kew, to *Origanum dubium*, Boiss., whilst Mr. E. M. Holmes, F.L.S., considers that it is *O. majoranoides*, Willd. Similarly the plant yielding the "Cyprus marjoram oil," now to be described, has been referred by Dr. Stapf to *O. majoranoides*, Willd., and by Mr. E. M. Holmes to *O. Maru*, Linn. Unfortunately, oils have never been distilled from typical specimens of the three species referred to, and consequently there are no chemical data on record with which the results of the work done at the Imperial Institute on the two Cyprus oils can be compared, so that no direct assistance to the settlement of the

botanical problem can be given from the chemical side at present.

The results so far obtained in the chemical examination of oils from Origanum species show that the oils are sharply divided into two groups: viz. a group containing either carvacrol or thymol as the chief constituent, and a group containing little or none of either of these phenols. "Cyprus origanum oil" belongs to the first group and contains over 80 per cent. of carvacrol. Cyprus marjoram oil belongs to the second group and contains not more than 2 per cent. of phenols, which have not yet been identified. Three samples of Cyprus marjoram oil have been submitted to preliminary examination at the Imperial Institute since 1909, but the results have not been published hitherto, partly because of the botanical difficulty already alluded to, and partly because the oil is of little commercial interest. It seems desirable, however, to put these results on record now, since they may assist in the clearing up of the difficult botanical problems which the genus Origanum presents.

Examination of Cyprus Marjoram Oil and Herb

Two samples of the oil and one sample of the herb have been received at the Imperial Institute, as well as herbarium specimens of the plant. Part of the latter were submitted to Dr. Stapf, of the Royal Gardens, Kew, for identification, and the remainder were supplied to the Museum of the Pharmaceutical Society, at the request of the Curator, Mr. E. M. Holmes. The identifications given by these authorities have already been quoted.

The two samples of Cyprus marjoram oil were pale yellow in colour; they possessed a pungent taste and a pleasant odour.

The sample of herb consisted mainly of flowers and leaves in broken condition. It also was examined by Dr. Stapf and Mr. Holmes and found by them to consist of the plant represented by the botanical specimens submitted to them. This herb, on distillation in the Imperial Institute laboratories, yielded 3·05 per cent. of

oil quite similar in properties to the two oils received from Cyprus, and which had been distilled there by the Agricultural Department of the island. The results of the preliminary examination of these three oils are given in the following table:

	Marjoram oil distilled in Cyprus.		Marjoram oil distilled from the Cyprus herb at the Imperial Institute, 1909.
	Sample No. 1 (1909).	Sample No. 2 (1911).	
Specific gravity at $\frac{15° C.}{15° C.}$	0·899	0·9126	0·888
Optical rotation in a 100 mm. tube	+ 14° 2′ at 21° C.	+ 3° 45′	+ 13° 15′ at 20° C.
Saponification value[1]	6·4	8·25	12·8
Saponification value[1] after acetylation	—	71·22	—
Solubility in 80 per cent. alcohol.	Soluble in 1·3 or more volumes.	Soluble in 1 or more volumes	Soluble in 8 to 9 volumes[2]
Percentage absorbed by 5 per cent. solution of caustic soda	—	—	2·0 (by volume)

[1] *Expressed as milligrams of caustic potash per gram of oil.*

[2] *This oil was distilled in* 1909; *on keeping it appears to become more soluble, as it is now* (*March* 1913) *soluble in* 1·4 *or more volumes of* 80 *per cent. alcohol.*

A detailed chemical examination of Cyprus marjoram oil at the Imperial Institute has been delayed by pressure of other work, but the results so far obtained show that the oil is somewhat similar to the "oil of sweet marjoram" described by Biltz in 1899 (*Berichte Deut. Ges.*, 1899, **32**, 995). The oil examined by Biltz was supplied by Schimmel & Co., of Leipzig, and was described as that of *O. majorana*, the plant commonly known as "sweet marjoram." A sample of this oil purchased from Messrs. Schimmel & Co., has been examined at the Imperial Institute, and the results are given in the following table along with those of Biltz, both being compared with a summary of the data afforded by the Cyprus marjoram oil and by oil distilled at the Imperial Institute from sweet marjoram herb of French origin. The French sweet marjoram herb distilled was examined by Mr. Holmes and found to consist of *O. majorana.*

	Results obtained at the Imperial Institute.			Biltz results.
	Cyprus marjoram oil.	Oil distilled from French sweet marjoram herb.[1]	Sweet marjoram oil distilled in Germany.	Sweet marjoram oil distilled in Germany.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$, unless otherwise stated.	0·888 to 0·912	0·895	0·901	0·898 at $\frac{14^\circ C.}{14^\circ C.}$
Optical rotation in a 100 mm. tube.	+ 3° 45′ to 14° 2′ at 20 to 21° C.	+ 14° 40′ at 23° C.	+ 17° 1′ at 20° C.	+ 15° 45′ at 15° C.
Saponification value	6·4 to 12·8	19	21	17
Solubility in 80 per cent. alcohol.	Soluble in 1 or more volumes	Soluble in 1·3 or more volumes	Soluble in 1·1 or more volumes	—
Percentage absorbed by 5 per cent. solution of caustic soda.	0 to 2·0 (by volume)	1·0—2·0 (by volume)	—	—

[1] *The herb used consisted mostly of leaves, but contained a few flowers ; it yielded* 0·3 *to* 0·36 *per cent. of oil in the two small consignments distilled* (*March* 1913).

On the whole the constants of the Cyprus marjoram oil are very similar to those of sweet marjoram oil as distilled in Germany, and as prepared from French sweet marjoram at the Imperial Institute, so that these results support to some extent Stapf's view that the Cyprus marjoram plant is *O. majoranoides* which is sometimes regarded as only a form of "sweet marjoram" (*O. majorana*). The Cyprus oil might very well replace sweet marjoram oil in commerce; but unfortunately the demand for sweet marjoram oil is very small, and consequently it is doubtful whether the distillation of the oil in Cyprus for export would be worth undertaking. Samples of the Cyprus oil were submitted to several firms, and it was ascertained that it might find a market at about 3*s.* to 3*s.* 6*d.* per lb., but that even if it could be sold at this rate the market would not be large.

BEESWAX FROM THE ANGLO-EGYPTIAN SUDAN

In a previous number of this Bulletin (1910, **8**, 23) attention was directed to some of the possibilities of an extended export of beeswax from various parts of Africa.

Since then a number of promising samples of this material have been received from the Anglo-Egyptian Sudan, and these are described below.

"Beeswax from Sennar Province." This consisted of a number of circular cakes, flat on the top and rounded on the bottom surface. The upper portions of the cakes were in most cases clean, and of yellowish-brown colour, but the lower portions were dirty, dark greyish-brown, owing to the settling out of dirt as the wax cooled after melting. The wax could be improved in appearance by re-melting and straining.

An average sample of the wax was found to contain 0·66 per cent. of dirt (matter insoluble in carbon tetrachloride) and 0·24 per cent. of ash. The amount of ash in the wax was normal, but the percentage of dirt was too high.

A sample of the wax was submitted for valuation to commercial experts, who stated that the material was dirty, and in this state might not realise more than £6 7*s.* 6*d.* per cwt., but if fairly clean its value would be £6 15*s.* to £6 17*s.* 6*d.* per cwt. ex warehouse, London (September 1911).

"Beeswax from the Yei River District." This sample consisted of a ball of wax, somewhat dirty on the outside, pale coloured, opaque, mottled, and free from obvious impurities.

The wax was submitted for valuation to brokers, who stated that the sample was very clean for rough ball, and worth fully £6 12*s.* 6*d.* per cwt., less 2½ per cent. discount, ex warehouse, London (December 1911). They added that beeswax of this description is easily saleable.

"Beeswax collected near Raga, in the Western District of the Bahr-el-Ghazal Province." This was a portion of a circular cake of pale-coloured wax, about 1¼ in. in thickness, and free from any appreciable amount of dirt except on the exterior. It was of a paler tint than the sample from the Yei River District, and was equally clean.

The wax was submitted to brokers, who valued it at £7 5*s.* per cwt., less 2½ per cent. discount, ex warehouse,

London (June 1912). Consignments of similar wax would be readily saleable.

"Beeswax collected in the Yambio District of the Bahr-el-Ghazal Province." Four samples of this product were submitted as follows:

"*A.*—'Light' or 'clear' as brought in." Irregular lumps of pale brown, unmelted wax containing much honey.

"*B.*—'A' after being boiled down to about ¼ of its original weight." Irregular fragments of yellow wax, about $\frac{3}{16}$ in. thick, covered with mould externally, but clean within.

"*C.*—'Dark' or 'dirty' as brought in." Irregular lumps of dirty, dark brown wax.

"*D.*—'C' after being boiled down to about ¼ of its original weight." Irregular lumps of yellow wax, fairly clean inside, but containing some dirt.

The specimens were examined with the following results:

	A.	B.	C.	D.
	Per cent	*Per cent.*	*Per cent.*	*Per cent*
Moisture	13·4	0·18	18·9	0·3
Dirt (approx.)	9·5	0·34	12·5	1·3
Water-soluble impurities, *i.e.* honey, etc. (approx.)	38·0	0·27	49·5	0·7
Wax (approx.) by difference	39·1	99·2	19·1	97·7

The materials represented by samples A and C could not be offered as beeswax in the United Kingdom. It might be possible to sell such products as raw material for the extraction of wax, but it would be very much better to export clean wax prepared as already described in this BULLETIN (*loc. cit.*).

Beeswax represented by samples B and D would be saleable in the United Kingdom, the former being worth about £6 12*s.* 6*d.* and the latter about £6 10*s.* per cwt., less 2½ per cent. discount (October 1912). Slightly higher prices would be obtainable for the wax if it were shipped quite clean in the form of cakes.

OIL-SEEDS FROM THE ANGLO-EGYPTIAN SUDAN

THE production of oil-seeds is one of the most important of the minor industries of the Sudan. In addition to sesamum, which is cultivated largely in the Kassala, Sennar, Kordofan, and the Blue and White Nile Provinces, ground nuts, senat, castor, safflower, and sunflower seeds are grown on a smaller scale, whilst the shea butter tree (*Butyrospermum Parkii*) occurs in many parts of the Bahr-el-Ghazal. The production of castor seed has not yet reached a commercial stage. The seed can be profitably grown in many parts of the Sudan, but the natives have not yet become aware of its value.

An export trade in several of these oil-seeds, as well as cotton seed, has already grown up, the statistics for the last three years for which figures are available being shown in the following table:

	1909.		1910.		1911.	
	cwt.	£	*cwt.*	£	*cwt.*	£
Sesamum . . .	122,640	64,709	116,213	67,717	97,134	73,427
Cotton seed . . .	36,342	9,267	33,643	10,749	139,810	32,406
Ground nuts . . .	5,804	3,688	18,172	8,959	22,100	13,400
Senat seed . . .	—	—	3,463	1,046	447	311

An account of the examination of shea kernels ("Lulu" nuts) and fat and castor seed from the Sudan has already been given in this BULLETIN (1908, **6**, 372; 1911, **9**, 26); in the following pages samples of sesamum, castor seed, senat seed, and *Salvadora persica* seeds, which have been received at the Imperial Institute in recent years, are dealt with. For an account of the cultivation and utilisation of sesamum seed, including particulars of the industry in the Sudan, see this BULLETIN (1911, **9**, 259).

SESAMUM SEED

"Sim-sim (sesame) seed, known locally as 'eirawi,' from the Gedaref district of Kassala Province." This sample consisted of white sesamum seed, mixed with 3·5 to 4·0 per cent. of extraneous matter, which could be removed by

sifting. The clean seed contained 4·7 per cent. of moisture, and yielded 51·0 per cent. of oil. This yield of oil is normal and satisfactory. The oil had the usual appearance of sesamum seed oil.

The sample was submitted to brokers, who stated that it was superior to the fair average grade of sesamum seed. They valued it at about £17 per ton delivered to European ports (May 1912), with large white Bombay seed at £19 per ton, and yellow Chinese at £18 7*s.* 6*d.* per ton.

"'Eirawi' sim-sim seed from the Gedaref district of Kassala Province." This consisted of white seed, mixed with a small quantity of extraneous matter. The clean seed yielded 51·2 per cent. of oil, which is normal and almost identical with the yield from the previous sample from the Gedaref District. The oil possessed the normal characters of sesamum seed oil.

The seed was submitted to brokers, who stated that it was of very good quality and valued it at £17 10*s.* per ton, delivered at European ports (August 1912), with large white Bombay seed at £17 17*s.* 6*d.* per ton.

Castor Seed

"Castor Seed from Nahud, Kordofan Province." Large, reddish-brown, mottled seeds, in good condition. A few broken seeds were present in the sample. The seeds yielded 50·5 per cent. of oil, representing a normal yield. The oil had the usual characters of castor oil.

This castor seed would realise about the same price as Bombay castor seed, which was then quoted at £12 per ton in London (September 1911).

"Castor Seed from Mongalla Province." Very small, grey seed, which yielded 43·3 per cent. of oil with the usual characters of castor oil.

The seed was submitted to a firm of oil-seed crushers, who reported that its value (January 1912) would be £10 12*s.* 6*d.* per ton, net weight, including bags, delivered free, ex ship Hull, less 2½ per cent. discount.

A small consignment of castor seed from the Sudan was sold in consultation with the Imperial Institute in

May 1912 at the rate of £12 5*s.* per ton, the current price of Bombay castor seed.

Senat Seed

The senat plant occurs as a weed in many parts of the Sudan, and is cultivated on a small scale in Central Gezira, and more generally in Managil and Blue Nile Province. Large quantities of the seed might be exported from the Kordofan Province if the cost of transport could be reduced, whilst a considerable quantity would be available also in the Tokar district of the Red Sea Province. Small quantities of the seed were first exported to Marseilles early in 1910, where it sold at about £12 per ton as a substitute for sesamum seed.

The oil expressed from the seed is well known to the natives, who use it for edible purposes. The seeds are also dried and eaten by the people after being crushed, whilst the leaves and fruit cases have been used as a cattle food.

Several forms of the plant are grown in different parts of the Sudan under the following names: "Hameid," "Fagus," "Ajurr," and "Tibish." Botanical specimens of the various forms have been received at the Imperial Institute and were submitted to the Director of the Royal Gardens, Kew, who stated that they all appeared to be cultivated races of *Cucumis Chate*, L. (*C. Melo* var. *agrestis*, Naud.; *C. arenarius*, Schum. et Thonn.). *C. Chate* is said to be indigenous in Egypt, Nubia, and Abyssinia, and Naudin considers it to be the wild type of the cultivated melon.

Six samples of the seed have been examined at the Imperial Institute, with the results given below.

No. 1.—Senat seed. Oval, flat, cream-coloured cucurbitaceous seeds, 0·7 cm. long and 0·35 cm. wide.

No. 2.—"Fagus" seed. This sample resembled No. 1, but was yellower and somewhat flatter.

No. 3.—Senat seed known locally in Kordofan Province as "Tibish." These seeds resembled in appearance the preceding samples, but they were of a greyish colour and somewhat less rounded in shape. The sample was in a dirty condition.

No. 4.—Senat seed from the Kadugli district of the Jebels Sub-Province, Kordofan. This sample resembled the preceding sample of "Tibish" seed, but was not so dirty.

No. 5.—"Hameid" seed. Light brown seeds, resembling senat seeds in shape and general appearance, but only about one-half as large.

No. 6.—Senat seed from Bara, Kordofan Province. Cream-coloured, flat seeds, rather larger than any of the previous specimens.

All the samples yielded a pale yellow liquid oil, free from smell or unpleasant taste. The oils from the various samples of seed were examined, with the results given in the following table, to which are added the figures for oils from other cucurbitaceous seeds.

	No. 1.	No. 2.	No. 3	No. 4.	No. 5.	No. 6.	Ikpan seed[3] from Southern Nigeria.	Melon seed (*Cucumis Melo*).	Water-melon seed (*Citrullus vulgaris*).
Yield . . . *per cent.*	36·5	31·0	29·5	31·7	30·2	38·4	25·4	43·8	40·8
Specific gravity at $\frac{15·5° C.}{15·5° C.}$	0·923	—	—	0·923	0·925	—	0·918–0·922	—	—
Acid value[1] . . .	1·0	—	—	0·7	0·7	—	1·4–5·5	—	—
Saponification value[1] .	192·0	190·5	189·3	189·2	187·0	—	194–196·5	193·3	189·7
Iodine value . *per cent.*	117·0	121·3	117·0	124·0	128·5	—	106–107	101·5	118
Titer test[2] . . .	30·3° C.	—	—	—	—	—	36° C.	36° C.	32° C.

[1] *Milligrams of potassium hydroxide per gram of fat.*
[2] *Solidifying point of fatty acids.*
[3] *Cf. this* BULLETIN, 1907, **5**, 132; 1908, **6**, 356.

In the case of No. 1 the Hehner value, *i.e.* the percentage of insoluble fatty acids and unsaponifiable matter, was 96·6; the percentage of unsaponifiable matter 0·7; and the Reichert-Meissl value, *i.e.* the quantity of decinormal alkali required to neutralise the volatile acids from 5 grams of fat, nil.

This senat seed oil is similar to the oils derived from other seeds of Cucurbitaceæ, and on account of its pale colour and freedom from smell and taste would be suitable for edible use.

Utilisation of Senat Husks

Senat seeds are contained in a melon-like fruit usually [ab]out three inches in length. With a view to ascertaining

the possibility of utilising the husk of the senat fruit after the removal of the seeds, samples of entire fruits, broken husks, and powdered husks were forwarded from the Sudan.

The powdered husks were examined in order to ascertain their suitability for use as a feeding stuff. The material was found to have the following percentage composition:

Moisture	10·63
Crude proteins	10·75
Consisting of:	
True proteins	5·43
Other nitrogenous substances	5·32
Fat	2·26
Starch, etc.	38·80
Fibre	20·50
Ash	17·06
Nutrient ratio [1]	1 : 4·1
Food units [2]	71·3

No cyanogenetic glucosides or alkaloids were present.

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The above results show that these senat husks have only a very low feeding value and contain much fibre and mineral matter. It is therefore evident that they would not form a desirable feeding stuff for cattle, except possibly as a diluent for richer materials.

In view of the high percentage of mineral matter (ash), it was thought they might be of value for manurial purposes. In order to determine this point an analysis was made of the ash, which was found to have the following percentage composition:

Lime	CaO	8·42
Magnesia	MgO	4·11
Potash	K_2O	42·69
Soda	Na_2O	0·70
Phosphoric acid	P_2O_5	2.51
Chlorine	Cl	2·08
Sulphuric acid	SO_3	3·85

These figures indicate that the mineral constituents senat husks should be of value as a manure, particular

for crops requiring potash. It is probable therefore that good results could be obtained by applying the husks direct to the soil as a manure.

Salvadora persica Seeds

S. persica, L., is a diffuse shrub or small tree belonging to the natural order Salvadoraceæ, which is found in a wild state throughout the Sudan, where it is known as "mustard tree."

The seeds received at the Imperial Institute were round, averaging about 0·15 in. in diameter, with thin shells of greyish colour, in many cases slightly mottled with brown. The kernels, which were bright yellow, possessed an unpleasant, bitter taste. The seeds yielded 44·6 per cent. of hard, bright yellow fat, with a faint, slightly unpleasant odour.

The fat was examined with the following results, compared with that from the seeds of *S. oleoides* from India:

	Present sample of *S. persica* seeds.	Seeds of *S. oleoides* from India.[1]
Specific gravity at $\frac{99^\circ C.}{15^\circ C.}$	0·867	0·908 (at 50° C.)
Acid value	9·3	11·3
Saponification value	245·2	242·4
Iodine value, *per cent.*	5·9	7·5
Titer test	30·4° C. (approx.)	40° C.
Melting-point	38° C.	41° C.

[1] *Figures recorded by Hooper in the Indian "Agricultural Ledger,"* 1908, *No.* 1.

The sample of the seeds was too small for commercial valuation. It may, however, be pointed out that the hardness and high melting-point of the fat render it suitable for the manufacture of candles, and if its unpleasant odour and taste could be removed by purification on a commercial scale it might possibly be employed in the preparation of vegetable butters and "chocolate fats."

In the Indian *Agricultural Ledger*, 1908, No. 1, *S. persica* and *S. oleoides* are considered to be distinct species, but in the *Index Kewensis* they are regarded as identical. The fat extracted from the present sample of seeds resembles that described in the *Agricultural Ledger* as the

fat of *S. oleoides*, and as the botanical identity of the Sudan plant would therefore be of interest, specimens have been requested for determination.

"CHEYI" SEED AND FIBRE

The name "Cheyi" is applied by the natives of Northern Nigeria to *Polygala butyracea*, Heck., a herbaceous plant occurring commonly in tropical West Africa. The seeds of this plant contain a valuable fat which can be utilised for edible purposes, whilst the stems yield a fibre which is used by the natives for making fishing-nets, cloth, thread, etc. A sample of the seed from Northern Nigeria has been received recently at the Imperial Institute, as well as samples of fibre and native-prepared thread. The results of examination of these specimens are given below.

Seed

The sample consisted of flat, oval seeds, about $\frac{1}{8}$ in. long and ¹ in. broad, brownish-black externally and greenish-yellow within. Some husks and other extraneous matter were present. The seeds yielded 37·9 per cent. of soft, yellowish fat, which possessed a pleasant taste and no distinctive odour.

The fat was examined with the following results, compared with those previously recorded for "Cheyi" fat:

	Present sample.	Results previously recorded.
Melting-point	36° C.	—
Specific gravity at $\frac{100° C.}{15·5° C.}$	0·866	—
Acid value [1]	1·24	11·4
Saponification value [1]	251·0	253·0
Iodine value, *per cent.*	52·5	49·4
Titer test [1]	37·85° C.	—
Hehner value,[1] *per cent.*	85·6	—
Reichert-Meissl value [1]	45·6	45·5

[1] *For the meaning of these terms, see p.* 59.

The fat contained 0·55 per cent. of unsaponifiable matter.

Samples of the seeds were submitted for valuation to

makers of edible fats and to oil-seed crushers, who furnished the following reports:

(1) The makers of edible fats were of opinion that "Cheyi" fat would be very suitable for their purposes if the seed arrived in the United Kingdom in good condition, and were proved to contain no poisonous constituents. On the basis of the yield of fat, they valued the seeds at about half the price of copra, which is now selling in the United Kingdom at £27 15*s.* to £29 10*s.* per ton (March 1913).

(2) The oil-seed crushers also regarded the seed and fat as likely to be of considerable commercial value. They were of opinion that the fat should eventually realise a good price for edible purposes. Assuming that the residual cake would be suitable for feeding cattle, a point that will have to be determined by trial, they considered the seed to be worth at least £12 per ton in the United Kingdom, and expressed a desire to receive a trial consignment of 100 tons, at this price, as a commencement.

Fibre

The sample consisted of strands of fibre somewhat resembling hemp in appearance, and varying in colour from pale yellow to brown. It was of good strength, and varied in length from 2 ft. to 4 ft., but was mostly between 3 ft. and 4 ft.

The fibre was examined with the following results, compared with Sunn hemp from India:

	Present sample. *Per cent.*	Sunn hemp (*Crotalaria juncea*) from India. *Per cent.*
Moisture	8·5	7·5
Ash	3·5	2·0
α-Hydrolysis, loss	21·7	17·9
β-Hydrolysis, loss	27·6	27·4
Acid purification, loss	5·7	3·6
Cellulose	69·9	75·6
Length of ultimate fibres	0·6 to 1·3 in.	0·08 to 0·4 in.

It was considered by experts to be equal in value to fine Bombay hemp (*Crotalaria juncea*), which was quoted in London at £26 to £27 per ton (April 1912). This price was unusually high, owing to a deficiency in the supply

of true hemp and the existence of a large demand; the normal value is about £17 to £18 per ton.

The results of the chemical examination indicate that this fibre somewhat resembles Sunn hemp of similar appearance and quality in its behaviour towards dilute alkali (a- and β-hydrolysis), but that it contains a lower percentage of cellulose, and might therefore be rather less durable. On the other hand, the ultimate fibres of which the Polygala fibre is composed are much longer than those of Sunn hemp, and about equal to the average length of those of true hemp (*Cannabis sativa*).

The commercial experts to whom the fibre was submitted reported that it was very strong and clean, and that it resembled Bombay hemp, but was rather shorter. They regarded it as a soft roping hemp of useful quality, but pointed out that a small proportion of the fibre was of dark colour and very weak.

There seems no doubt that fibre of the quality of this sample would be readily saleable in large quantities in the United Kingdom as a substitute for hemp, and enquiries are being made as to whether it could be produced in Northern Nigeria on a sufficiently large scale for export.

Native-prepared Thread

The sample was prepared from fibre grown in Kupa district, Kabba Province, Northern Nigeria. It consisted of two hanks of an unevenly spun thread or yarn, which had been made by twisting together the ultimate fibres of a non-lignified material somewhat resembling flax and ramie.

The ultimate fibres composing the thread had an average length of about 1·5 in., and an average diameter of about 0·00114 in. They were of fairly regular diameter, and exhibited transverse markings and knot-like joints similar to those of flax; the markings, however, were not always well developed. In many cases a narrow lumen was present. The fibre was fairly strong, but lacking in elasticity.

"Cheyi" fibre, in the condition represented by the

material of which this thread was composed, might possibly be of commercial value in the United Kingdom for spinning purposes, if obtainable in large quantities and at a price which would enable it to compete with cotton and flax. The fibre, however, was much less elastic than cotton, and lacked the peculiar spirally twisted structure to which the spinning properties of the latter are due. For this reason it is somewhat doubtful whether the fibres would cohere sufficiently to permit of their being spun by the ordinary cotton-spinning machinery. Moreover, "cheyi" fibre does not possess the advantage of length which enables flax to be spun. Flax fibre consists of strands averaging 20 in. in length, whilst the ultimate fibres of *Polygala butyracea*, which alone could be employed for spinning, are only about 1½ in. long.

ZAPUPE FIBRE

Considerable interest has been taken in recent years in Zapupe fibre, which has been introduced into commerce as a substitute for Sisal hemp. As in the case of the latter fibre, Zapupe is obtained from the leaves of certain species of Agave, but the exact botanical source is unknown. The plant occurs wild in the State of Vera Cruz, Mexico, and has been cultivated in the Canton of Tuxpam in that State since about 1901 or 1902. The plant is stated to give better results under varied conditions of soil and climate than Sisal, and as it requires little attention in cultivation it seems probable that, once its value is known, its cultivation will be taken up in other countries.

The best situations for the cultivation of Zapupe are gently sloping plains, or the lower slopes of mountains, with a fairly rich soil of not too porous a nature. As the plant is essentially tropical, it will not flourish at high altitudes. It is usually propagated by means of suckers which are removed from the parent plant when a few inches high, and planted in specially prepared nurseries. After about eight to ten months the plants, now 1 or 2 ft. high, are removed to their permanent quarters and set in rows 7 ft. apart, with a distance of 5 ft. between the plants.

The cutting of the leaves is begun when the plants are four or five years old, and may be continued for a period of about eight or ten years, when the plant produces a large inflorescence, bearing numerous bulbils, which may be used for propagation. An average of about eighty leaves, giving a total yield of about 2½ lb. of fibre, is obtained per annum from each plant in three cuttings.

Two samples of Zapupe fibre have been examined recently at the Imperial Institute, with the results given below:

No. 1.—This sample consisted of well-cleaned and well-prepared, lustrous fibre, almost white, and of good strength. The length of staple was irregular, in some cases reaching 4 ft. 8 in.

The fibre was analysed with the following results, compared with corresponding figures for Mauritius hemp and for Sisal hemp from the East Africa Protectorate:

	Zapupe fibre. *Per cent.*	Mauritius hemp. *Per cent.*	Sisal hemp. *Per cent.*
Moisture . . .	11·2	13·0	11·1
Ash	1·2	2·5	1·0
α-Hydrolysis, loss .	11·8	7·5	11·2
β-Hydrolysis, loss .	15·7	18·3	14·1
Acid purification, loss	2·7	2·0	2·3
Cellulose . . .	77·3	76·4	78·2
Length of ultimate fibres . . .	From 0·05 to 0·14 in.; average 0·094 in.	From 0·05 to 0·15 in.	From 0·06 to 0·16 in.

It is evident from these figures that the Zapupe fibre approximated very closely to Sisal hemp in chemical behaviour and composition, and that it was somewhat superior to the sample of Mauritius hemp with which it was compared, this superiority being shown particularly by the smaller loss on β-hydrolysis (*i.e.* boiling for one hour with 1 per cent. caustic alkali).

No. 2.—This sample consisted of strong, lustrous, well-cleaned, and well-prepared fibre, of rather irregular colour, varying from cream to brownish-yellow, and generally darker than sample 1. The length of staple was irregular, up to as much as 4 ft. 4 in. This sample was not submitted to chemical examination.

The specimens were submitted to a firm of fibre merchants, who stated that they had not previously seen such good specimens of Zapupe fibre, adding that the samples were of good growth and especially well prepared. They valued No. 1 at about £32 and No. 2 at £30 per ton in London (January 1913), with Mexican Sisal at £34, and best quality Mauritius hemp at £28 to £30 per ton.

This Zapupe fibre should always be readily saleable in the United Kingdom, but the valuations given above are considerably higher than usual, owing to the recent increase in the price of Sisal and other cordage fibres.

"CABBAGE TREE" FIBRE FROM NEW ZEALAND

A SAMPLE of "cabbage tree" fibre was received recently at the Imperial Institute from New Zealand for examination. No information was supplied as to the botanical origin of the fibre, but according to Cheeseman (*Flora of New Zealand*) the name "cabbage tree" is applied to *Cordyline australis*, and the present sample of fibre was probably from that source. It was fairly well prepared, but rather pulpy, of poor lustre, harsh, and somewhat brittle. The colour was uneven, being mostly deep cream, whilst some portions of the sample were greenish. The fibre was of irregular strength, most of it being strong, but some parts weak, especially at the ends. The length varied from 1 ft. 5 in. to 2 ft. 10 in., being mostly from 2 ft. 3 in. to 2 ft. 6 in.

The fibre, after hackling, was analysed with the following results:

	Per cent.
Moisture	13·8
Ash	1·0
α-Hydrolysis, loss	20·3
β-Hydrolysis, loss	22·5
Acid purification, loss	5·4
Cellulose	69·5
Length of ultimate fibres	From 0·03 to 0·32 in.; average, 0·13 in.

The fibre was submitted to brokers, who stated that if it were 3 to 4 ft. in length it would be worth £25 per ton in

London (November 1912), with Mexican Sisal at £34 per ton.

From the appearance of this sample of "cabbage tree" fibre, and from the loss which it underwent on acid purification, it is evident that it had been insufficiently cleaned. The rather low percentage of cellulose and the loss on α-hydrolysis (*i.e.* boiling for five minutes with 1 per cent. alkali) were probably largely due to the same cause.

The comparatively small difference between the losses on α- and β-hydrolysis (the latter being the process of boiling the fibre for one hour with 1 per cent. alkali) indicates that the actual fibre substance was not readily attacked by dilute alkali, and that it would probably be very resistant to the prolonged action of water. The fibre could therefore be used for rope-making purposes, but in order to realise good prices it should be at least 3½ to 4 ft. in length.

"ELEPHANT GRASS" AS A PAPER-MAKING MATERIAL

"Elephant grass" (*Pennisetum purpureum*, Schum. = *P. Benthamii*, Steud.) is a perennial grass growing usually to a height of 6 to 10 ft., and occasionally, on rich marshland, up to 20 ft. It occurs in a wide zone across tropical Africa extending from 10° N. Lat. to 9° S. Lat. on the west coast, and from 9° to 20° S. Lat. on the east coast. It is found chiefly along watercourses and in marshy depressions, but also grows in the more open parts of the bush and forest. In the delta of the Zambesi and along the Shire river it forms extensive reed jungles. The grass has been recommended as a green fodder (see *Kew Bulletin*, 1912, p. 309); it is resistant to drought, and is said to remain green late into the autumn in Rhodesia, and to withstand frost to a remarkable degree. Both cattle and horses eat it readily.

A sample of the dried mature grass was sent to the Imperial Institute recently from Uganda, with a view to ascertaining its suitability for paper-making. The Chief Forestry Officer stated that the grass is a source of great

annoyance and expense to agriculturists in that Protectorate, as it grows with great rapidity after the aerial shoots have been either burnt or cut down, but that if it could be profitably used for the manufacture of paper a new and large industry could be built up.

The consignment, which weighed 177 lb. when received at the Imperial Institute, consisted of two bundles of yellow, bamboo-like stems measuring up to 11 ft. in length, with nodes at intervals of a few inches; the diameter of the stems at the base was about 1 inch. Towards the tips the stems bore small branches and thin papery leaf-sheaths.

The stems in the interior of the bundles were moist and mouldy on arrival, and they were therefore spread out and air-dried. After drying in this way the consignment weighed 145 lb.

The air-dried stems were examined with the following results, compared with corresponding figures recorded for Algerian esparto grass and for bamboo:

	"Elephant grass."	Algerian esparto grass.	Bamboo.
	Per cent.	*Per cent.*	*Per cent.*
Moisture on drying at 100°–110° C.	10·7	8·8	10
Ash expressed on the dried material	5·1	3·0	5
Unbleached pulp:			
Expressed on material as received	23·9	—	—
Expressed on air-dried material	29·0	29·5	32 to 42
Expressed on material dried at 100°–110° C. . .	32·5	32·3	—
Length of ultimate fibres	0·05 to 0·14 in.; average 0·08 in.	0·012 to 0·12 in.; average 0·045 in.	0·024 to 0·16 in.; average 0·096 in.

The pulp was of good colour, and was composed, as indicated above, of ultimate fibres rather longer than those of esparto grass, and of about the same length as those of bamboo pulp. It furnished a fairly good paper.

In preparing pulp from this "elephant grass" at the Imperial Institute no difficulty was occasioned by the nodes, so that it should not be necessary to cut these out when utilising the stems for paper-making, as is sometimes

recommended in the case of bamboo (compare this BULLETIN, 1912, **10**, 676.) It may, however, be mentioned that the nodes are stated to have caused some difficulty in trials carried out in Germany with "elephant grass" from Togoland.

On account of the light and bulky nature of "elephant grass" it is very unlikely that the stems could be profitably shipped to Europe for paper-making, as they would probably only realise about the same price as esparto grass of average quality, viz. £3 7*s.* 6*d.* per ton (February 1913). If, however, the stems were converted into pulp in Uganda by treatment with caustic soda, it is possible that a remunerative industry might be carried on, since the pulp would probably be of approximately the same value for paper-making as wood pulp prepared by the soda process, viz. £7 10*s.* to £8 12*s.* 6*d.* per ton in London (February 1913).

THE COTTON INDUSTRY OF NORTHERN NIGERIA

COTTON has long been cultivated by the natives of Northern Nigeria, and the markets in the more northern parts have been frequently visited by caravans from North Africa in order to obtain the cotton used in the weaving industry of that part of the continent. Hitherto transport difficulties have prevented the cotton of the northern districts being exported to the United Kingdom, but the completion of the Baro-Kano railway will enable this vast and populous area to be tapped. Up to the present the efforts to encourage cotton cultivation amongst the natives have been confined to the Niger and Benue valleys, and with this end in view the British Cotton Growing Association erected ginneries at Lokoja, at the junction of the Benue and Niger rivers, and at Ogudu on the Niger, in the Ilorin Province. More recently a large ginnery has been erected at Zaria, further north. The Ogudu ginnery, however, was closed on the opening of the Lagos Government Railway, the cotton from this district being ginned in Southern Nigeria.

In the Kano and other northern districts the indigenous cotton is short-stapled with white lint, whilst that of the Benue and Niger valleys is long-stapled with tinted lint. Plantations have been formed by the British Cotton Growing Association at Lokoja and Ogudu, where experimental work has been carried out on the acclimatisation of exotic seed, selection of native seed and varieties, rotation of crops, time of planting, comparative tests of varieties, cultivation by draught animals, etc. Exotic cottons have also been experimentally cultivated at some of the gaol farms.

Complete statistics of the exports of cotton from Northern Nigeria are not available, but some idea of the production may be gained from the following figures, showing the quantity of unginned cotton purchased by the British Cotton Growing Association and by merchants in recent years:

	Tons.		*Tons.*
1904	156	1909	375
1905-6	362	1910	111
1907	368	1911	230
1908	152		

A large number of samples of cotton, chiefly indigenous varieties, from Northern Nigeria, have been examined at the Imperial Institute, and an account of the results of examination of the earlier samples will be found in this BULLETIN (1909, **7**, 158), and in *British Cotton Cultivation*, by Prof. Wyndham Dunstan, *Colonial Reports, Miscellaneous Series*, No. 50 [Cd. 3997], 1908, whilst a description of the native cotton industry of the Protectorate has been published in this BULLETIN (1905, **3**, 50). The samples received in recent years are dealt with in the following pages.

Indigenous Cottons

No. 1—Munshi Cotton, Doma Section. This sample of seed-cotton yielded on ginning 35 per cent. of lint, the yield per 100 seeds being 5·16 grams. The lint was fairly soft, lustrous, and of an even cream colour, with very occasional reddish-brown stains. The seeds were of medium size, smooth and dark brown in colour, with light

brown tufts at the pointed ends; 13 per cent. of the seeds examined were withered, and would be useless for sowing.

The cotton was of normal strength, and varied in length from 1·1 to 1·3 in., the diameter ranging from 0·0006 to 0·0011 in., with an average of 0·00081 in.

Although this cotton was somewhat harsher than American Upland, it was of good quality, and would no doubt be useful as a medium staple cotton, with applications similar to those of Upland varieties. It was valued at about $5\frac{3}{8}$*d.* per lb. (ginned), with "middling" American at 6·56*d.* per lb.

No. 2.—Native Nupe. This was grown at the Government Experimental Farm, Baro, and consisted of ginned cotton, soft and fairly lustrous, but stained to such an extent as to be almost of uniform reddish-brown colour. The strength of the cotton was uneven, some portions being very weak. The length varied from 1·0 to 1·3 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00074 in.

The nominal value of this cotton was $4\frac{1}{2}$*d.* to 5*d.* per lb., with "middling" American at 6·55*d.* per lb., but although valued at only $1\frac{1}{2}$*d.* to 2*d.* per lb. below "middling" American cotton, it is doubtful whether material such as represented by this sample would be of any commercial utility. The colour of the cotton suggested that it had suffered greatly from the attacks of insect pests, followed by exposure to the weather.

This experiment in cotton-growing at Baro is referred to by the Inspector of Agriculture in his Third Report (1909) on the Agricultural and Forest Products of Northern Nigeria, in the following terms:

"It appeared that the plot irrigated at Baro had been planted too late, as the plants were commencing to fruit at the beginning of May, when the heavy showers which occurred induced them to produce a useless growth of leaf at the expense of bolls. The fruiting might possibly have been accelerated by the stoppage of irrigation when the first bolls had formed, and by the subsequent supply of very small quantities of water only, as each new series commenced to form."

No. 3.—This sample of native seed-cotton yielded on ginning 32·5 per cent. of lint, the yield per 100 seeds being 4·2 grams. The lint was fairly soft and lustrous, mixed in colour, varying from pale reddish-brown to white, with some brown and occasional bright red stains. The seeds were of average size, closely covered with a thick down, and varying in colour from light-brown to greenish-brown; 20 per cent. of the seeds examined were withered and would be useless for sowing.

The cotton was of normal strength, and varied in length from 0·8 to 1·1 in., the diameter ranging from 0·0005 to 0·0010 in., with an average of 0·00081 in.

The ginned cotton was worth about 7¼*d.* per lb., with "fully good fair" brown Egyptian cotton at 11⅝*d.* per lb., and "middling" American at 7·59*d.* per lb. It was of somewhat poor quality, being short in staple and uneven in colour; on ginning, the brown and white cotton became mixed, when the whole somewhat resembled brown Egyptian cotton. Its market value should therefore be regarded as that of a low quality of Egyptian cotton rather than American Upland, although its shortness would render it more suitable for use as a substitute for Upland than for Egyptian cotton. The stains on the cotton indicated the presence in the crop of insect pests, probably of *Dysdercus* sp.

No. 4.—Cotton from Keffi Division, Nassarawa Province. This sample of seed-cotton yielded on ginning 30 per cent. of lint, the yield per 100 seeds being 3·5 grams. The lint was soft, fairly lustrous, and of deep cream colour, with a rather large quantity of reddish-brown stains. The seeds were of medium size, and generally closely covered with a short greenish-brown or white down. Occasional smooth brown seeds were also present; 20 per cent. of the seeds examined were withered and would be useless for sowing.

The cotton was of uneven strength, some portions being rather weak. The length varied from 0·9 to 1·3 in., and the diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00079 in.

The value of the ginned cotton was about 7*d.* per lb.,

with "middling" American at 8·04*d.* per lb. It was of fairly good quality, but was depreciated in value by the presence of stains which appeared to have been caused by insect pests in the crop. Greater care in cultivation would no doubt result in the production of a superior type of cotton, and one which would meet with a ready sale in the United Kingdom.

No. 5.—Cotton from Illushi. This cotton was somewhat harsh, fairly lustrous, and of deep cream colour with occasional small brown and pale yellow stains. The strength was generally normal, but some portions were weak. It varied in length from 0·8 to 1·5 in., but was mostly between 1·0 and 1·2 in. The diameter ranged from 0·0006 to 0·0012 in., with an average of 0·0009 in. The material is thus somewhat coarser than American Upland cotton.

This cotton was of very good quality and readily saleable in the English market. It was valued at about 1*d.* per lb. in advance of "middling" American. The cultivation of this variety might well be extended, as the product is much superior to most of the cotton grown in West Africa.

No. 6.—Four samples of "Bassa" seed-cotton grown at the Zungeru Prison Farm, at different distances apart, gave the following yields of lint on ginning:

Spacing	2 ft. × 2 ft.	2 ft. × 3 ft.	3 ft. × 3 ft.	4 ft. × 3 ft.
Yield, *per cent.* . .	33·0	32·8	33·1	33·9
Yield per 100 seeds, *grams*	4·44	4·48	4·89	4·88

The lint of all the samples was clean, fairly soft, of rather dull appearance, and of cream colour with occasional brown and yellow stains. The seeds were of varying size and character, some being covered with white or green fuzz, whilst others were smooth and dark brown; about 20 per cent. of the seeds examined were defective, some being withered or mouldy and others attacked by insects.

The cotton was of good strength but somewhat irregular in length, varying from 1·0 to 1·5 in., but mostly about 1·1 to 1·3 in. The diameter ranged from 0·00065 to 0·0011 in., with an average of 0·00080 in.

The ginned cotton was valued at 8·06*d.* per lb., with "middling" American at 7·96*d.* per lb. It was of useful quality, but its value would have been higher if it had been of brighter appearance and free from stains. The different spacing of the plants does not appear to have produced any difference in the quality of the cotton, as the four samples were practically indistinguishable from one another.

No. 7.—Two samples of "Ilorin" seed-cotton, also grown at the Zungeru Prison Farm, at different distances apart, gave the following yields of lint on ginning:

Spacing	2 ft. × 2 ft.	3 ft. × 2 ft.
Yield, *per cent.*	31·0	31·4
Yield per 100 seeds, *grams*	4·06	3·95

The lint of both samples was clean, fairly soft, of rather dull appearance, and of cream colour with occasional pale brown stains. The seeds were of medium size, and rather varied, being in most cases covered with white, green, or brown fuzz, whilst some seeds were dark brown and smooth; about 20 per cent. of the seeds examined were defective, some being withered and mouldy, whilst others had been attacked by insects.

The strength of the cotton was good, but the length rather irregular, varying from 1·0 to 1·5 in., but mostly from 1·1 to 1·3 in. The diameter ranged from 0·00065 to 0·0010 in., with an average of 0·00079 in.

This cotton closely resembles that of the Bassa variety (No. 6), and was valued at the same price. The two samples were indistinguishable from one another, so that in this case also the spacing of the plants does not seem to have affected the quality of the product.

Both the Bassa and Ilorin cottons were of useful quality and would be readily saleable.

No. 8.—Two samples of native cotton, grown on prepared ground at Zungeru Government House, were received. In one case the ground had been manured, and in the other it had not. They gave the following yields of lint on ginning:

	Manured.	Unmanured.
Yield, *per cent.*	32·5	30·01
Yield per 100 seeds, *grams*	4·49	4·52

The lint of both samples was clean, fairly soft, rather lacking in lustre, and of cream colour with occasional stains. The seeds were fairly large and varied, some being coated with white, brown, or green fuzz, whilst others were smooth, dark brown, or black, with a tuft of fuzz at one end; about 20 per cent. of the seeds examined were defective, being withered, mouldy, or attacked by insects.

The cotton was of good strength, but the length was irregular, varying from 1 in. to 1·7 in., but was mostly about 1·2 to 1·5 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00080 in.

This cotton was very similar to the Bassa and Ilorin varieties (Nos. 6, 7), and was valued at the same price. The effect of manuring is not apparent in the quality of the first sample as compared with the second, but it may possibly have increased the yield.

No. 9.—This sample from the Muri Province consisted of clean, coarse, rough, curly, lustrous cotton, white and free from stains. It was of good strength, and varied in length from 0·9 to 1·3 in., but was mostly from 1·0 to 1·2 in.

This cotton was valued at about 9·10*d.* per lb., with "middling" American at 8·37*d.* per lb., and "good" moderately rough Peruvian at 10·50*d.* per lb. It was of excellent quality, and somewhat resembled rough Peruvian in character, but was shorter. It would probably be useful for mixing with wool in the production of "union" yarns.

No. 10.—"Matankanawa" seed-cotton from Kazaure, Kano Province. Two leaves of the plant were forwarded with the sample. The lint obtained on ginning was clean, moderately lustrous, fairly soft, greyish-white, and free from stains. The seeds were of medium size, and coated with a green or brown fuzz.

The cotton was of fair strength, and varied in length from 0·7 to 1·3 in., but was mostly from 0·9 to 1·1 in. The diameter ranged from 0·0005 to 0·0009 in., with an average of 0·00073 in.

The nominal value of the cotton was about the same as "middling" American cotton, which at the time of the report was quoted at 6·62*d.* per lb. in Liverpool (April 1912).

This cotton is a form of *Gossypium arboreum*, Linn. In the absence of flowers it was not possible to identify the variety, but it seems not improbable that it may be the form known as *G. arboreum*, Linn., var. *sanguinea*, Watt, which has been previously observed by Dudgeon in Southern Nigeria and the Bassa Province of Northern Nigeria (see p. 16 of *Papers and Reports on Cotton Cultivation*, presented to the International Congress of Tropical Agriculture, held at Brussels in May 1910).

The cotton was of good, useful character, but the colour was rather unsatisfactory. It is probable that it could be improved by cultivation.

No. 11.—Tree cotton found at Kpada, near Egga. This sample of seed-cotton yields a clean, fairly lustrous lint, rather harsh, white, and free from stains. The seeds were small, and covered with a green fuzz.

The strength of the cotton was fairly good, but somewhat uneven. The length varied from 0·7 to 1·1 in., and the diameter ranged from 0·0006 to 0·0012 in., with an average of 0·00084 in.

In general appearance this cotton somewhat resembled the preceding sample of "Matankanawa" cotton, and botanical specimens which accompanied it have been identified at Kew as belonging to the same species, *G. arboreum*, Linn. It was not quite so long as the cotton from Kazaure, and was decidedly coarser; like the latter, however, it was of useful character, and could probably be much improved by cultivation.

No. 12.—Native cotton (*G. peruvianum*) from Ilorin. This seed-cotton yielded on ginning 33·2 per cent. of lint, the yield per 100 seeds being 4·0 grams. The lint was rather dusty, fairly soft, fine, of poor lustre and irregular colour, varying from dark reddish-brown to almost white, with a large number of yellow stains. The seeds were of medium size, some being chocolate brown in colour, bearing no fuzz, and others covered with a green or brown fuzz of medium length. The strength was irregular, but fairly good on the whole. The length varied from 0·8 to 1·4 in., but was mostly from 1·0 to 1·2 in.

The ginned cotton was valued at 6·00*d.* per lb., with

"middling" American cotton at 6·60*d.* per lb. It was of promising quality on the whole, but was of mixed and irregular staple. The characters of both seed and lint suggested that the product was derived from plants of more than one variety. It is not unlikely that by making a selection from the best plants in the field a useful and valuable form of cotton might be established.

Improved American Upland Cottons

No. 13.—Two samples of Nyasaland Upland seed-cotton, grown at different distances apart at the Zungeru Prison Farm, were examined. They gave the following yields of lint on ginning:

Spacing	2 ft. × 2 ft.	3 ft. × 2 ft.
Yield, *per cent.* . . .	31·7	31·7
Yield per 100 seeds, *grams* .	3·82	3·80

The lint in each case was clean, soft, lustrous, and white to pale cream in colour, with occasional stains. The seeds were of medium size, and covered with fuzz which was in most cases white, but occasionally green. About 20 per cent. of the seeds examined were defective, some being withered or mouldy and a small proportion attacked by insects.

The strength of the cotton was uneven and the length rather irregular, varying from 1·0 to 1·5 in., but mostly 1·1 to 1·3 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00075 in.

The ginned cotton was valued at 8·10*d.* per lb., with "middling" American at 7·96*d.* per lb.

These two samples were exactly alike, and were of good quality, but somewhat irregular in length and strength. These defects were probably due to some of the cotton having been gathered before it was quite ripe. If it is intended to grow this cotton on a commercial scale in Northern Nigeria, considerable care will be required in acclimatising and establishing it. In this connection reference should be made to the recommendations of the Director of the Department of Agriculture in Nyasaland in his Report for 1910 (see this BULLETIN, 1910, **8**, 372).

No. 14.—Allen's Improved seed-cotton, grown by the Agricultural Department at Bida. This sample yielded on ginning 30·0 per cent. of lint, the yield per 100 seeds being 4·06 grams. The lint was clean, soft, silky, fine, lustrous, of pale cream colour, almost white, with a few small yellow or brownish stains. Some portions of the sample were immature. The seeds were of medium size, and covered with a white, greenish, or brownish, fairly long fuzz.

The strength of the cotton was irregular, but fair on the whole. Some weak, immature cotton was present. The length was also irregular, varying from 0·7 to 1·5 in.

The ginned cotton was valued at 9*d.* per lb., with "middling" American cotton at 6·60*d.* and "fully good fair" Abassi cotton at 10¼*d.* per lb.

This cotton, whilst maintaining the usual characters of the "Allen's Improved" variety, had apparently suffered from being grown in a new country. It was stated that the seed had been sown too late, and this no doubt would account for the fact that a small proportion of the fibre had not ripened properly, and that in consequence the sample was rather uneven both in length and strength. The result of the experiment, however, was regarded as sufficiently encouraging to warrant its continuance with a view to the acclimatisation of the variety.

SOME FLOSSES OR SILK-COTTONS

Considerable interest has been taken in recent years in the utilisation of flosses or silk-cottons, which consist of the soft, silky hairs attached to the seeds or inner walls of the seed-capsules of many plants belonging to the Malvaceæ, Apocynaceæ, Asclepiadaceæ, etc. The most important of these is kapok, derived from *Eriodendron anfractuosum*, DC. (Malvaceæ), of which an account has already been given in this Bulletin (1911, **9**, 121). Kapok is chiefly used at the present time as a stuffing material in upholstery, but machinery has been devised for spin-

ning this and similar flosses (see this BULLETIN, 1911, **9**, 70), and there should be an increased demand for such materials in the future. In the following pages an account is given of the examination of various flosses received in recent years at the Imperial Institute.

KAPOK FROM THE FEDERATED MALAY STATES

The sample was clean, of light brown or yellow colour, very soft to the touch, slightly wavy, of silky lustre, and 0·6 to 1·0 in. long. On microscopical examination, the fibre was found to be very smooth, transparent, and of irregular diameter, varying from 0·0006 to 0·0012 in.

On chemical examination the following results were obtained, which are compared with those furnished by a commercial sample of Java kapok:

	Present sample. *Per cent.*	Java kapok. *Per cent.*
Moisture	8·1	10·9
Ash	1·6	1·3
Cellulose	60·5	64·3

It is evident from these results that the floss was very similar in chemical composition to Java kapok, but contained a somewhat smaller percentage of cellulose. It was also of darker colour and somewhat less lustrous than the standard commercial sample of kapok with which it was compared, but was of approximately the same length.

Commercial experts who examined the sample reported that it was of good quality, clean, of fair colour, rather short, curly, much superior to ordinary Indian kapok, and also better than the Ceylon variety. They added that if the product could be shipped in fair quantities, say 50 or 100 bales of about 160 lb. each, it would probably be saleable in the London market at a price a little higher than ordinary Indian kapok, which is at present worth about $6\frac{1}{2}d.$ to $7\frac{3}{8}d.$ per lb. (January 1913).

The opinion was expressed that the material would make a better filling for upholstery purposes than the ordinary Indian product, and would be preferred by buyers.

Kapok from British Honduras

This sample consisted of fairly lustrous, soft, dark grey floss, mixed with a large proportion of seed and some capsules and pieces of twigs and branches.

The resiliency of the floss appeared to be about equal to that of ordinary Java kapok. The length of fibre was from 0·6 to 0·9 in.

The material was submitted to commercial experts, who considered that, owing to the dark grey colour of the sample and the high percentage of seed which it contained, its value would not be more than about 2¼*d.* to 2½*d.* per lb. in London (August 1911). They added, however, that it is very difficult to value exactly a small quantity, and expressed a wish to receive a sample of 1 cwt. for thorough trial.

A second firm stated they could use this kapok if obtainable at a suitable price, and they considered that it might realise 3*d.* per lb. in London, or possibly a little more.

This kapok was of low commercial value owing to its poor colour and to the large percentage of seed present. It would be of interest to learn whether the kapok produced in British Honduras is always grey in colour, or whether it can be obtained bright and glossy like Java kapok.

Asclepias fruticosa Floss from the Transvaal

The sample consisted of a lustrous, very pale yellow floss, resembling thistledown in appearance. The material was lacking in resiliency. A considerable proportion of seeds, capsules, and pieces of twig was present.

The yield of fibre obtained on passing the sample through a roller cotton gin was only about 28 per cent. The ginned product still contained a small quantity of fragments of capsules.

The material was weak and brittle, as is usually the case with floss, but its strength was about equal to that of Java kapok. The length of the fibres varied from 0·7 to 1 in.

This floss could probably be utilised as a stuffing

material in upholstery, but it would not be so valuable for this purpose as kapok, as it is much less resilient than the latter. From the reports of brokers to whom samples of ginned and unginned floss were submitted it appeared that the material as received from South Africa would only have a nominal value of ½*d.* or 1*d.* per lb. in London, but that the ginned product should realise 2½*d.* to 4½*d.* per lb., with Java kapok at 8½*d.* to 9½*d.* per lb. and Calcutta kapok at 5*d.* to 5¾*d.* per lb. (December 1911). For upholstery purposes the floss would have to be freed from the seeds, but this could probably be effected by treating it in one of the machines specially designed for cleaning kapok. This latter point could, however, not be determined with the small quantity of floss available at the Imperial Institute.

The material was also submitted to a German firm who have devised a special process for spinning flosses. This firm stated that the Asclepias floss would be quite suitable for their purpose, and that they could probably purchase large quantities of it in the raw, unginned state. The precise value of the material could not be ascertained without technical trials, but would probably be under 2½*d.* per lb. The firm expressed a desire to receive a few bales of the floss in order to carry out a trial with it and report definitely as to its value.

This Asclepias floss from South Africa would probably find a market as a substitute for kapok in upholstery, and could also be utilised for spinning. Technical trials would, however, be required to determine its precise value for these purposes.

Asclepias semilunata Floss from Uganda

The sample consisted of soft, lustrous, and fairly resilient fibre. It was generally of an even pale yellow colour, but some dark brown stained portions were also present. The floss contained a large quantity of small dark brown seeds, of somewhat irregular shape. The strength was rather poor, as is usually the case with flosses, and the length of staple varied from 1·0 to 1·6 in.

This floss was superior to that of *A. fruticosa* (*see above*), and would have a slightly higher value.

Cryptolepis Floss from Rhodesia

This sample of floss was stated to be derived from a plant growing wild in North Western Rhodesia and known as "Kawulembi." Herbarium specimens of the plant were received along with the floss and identified at Kew as a species of Cryptolepis, probably *C. oblongifolia*, Schltr. (Asclepiadaceæ), but flowering specimens would be required to establish the exact identity.

The floss was clean, pale yellowish-brown in colour, very lustrous, straight, and soft to the touch. The strength was fairly good for material of this kind. The fibres varied in length from 1·0 to 1·25 in. and in diameter from 0·0008 to 0·0014 in., with an average of 0·0010 in.

This material could be used as a stuffing material for upholstery, but would be of less value than kapok for this purpose, since the straightness of the fibre, judging from the present sample, would cause a lack of resiliency, which is one of the most desirable properties of an upholstery material and one possessed to a large extent by kapok on account of the curly or waved nature of its fibres.

M'ZIMBITI TIMBER FROM MOZAMBIQUE

"M'Zimbiti" or "Makruss" timber is the product of a tree, *Androstachys Johnsonii*, Prain, belonging to the Euphorbiaceæ. According to W. H. Johnson, late Director of Agriculture in the territories of the Mozambique Company, the tree is abundant in the low country of the Manica and Sofala territories, Mozambique, but appears to flourish only in the neighbourhood of streams, where it often constitutes 90 per cent. of the tree vegetation. The timber is well known on the Lebombo Mountains, on the western boundary of Mozambique, where the tree occurs in dense, pure thickets. The trunk may reach a circumference of 6 ft. and is frequently unbranched up to a height of 40 ft., but very large specimens are said to be usually hollow.

A log of this timber, about 7 ft. long and 2 ft. in diameter, and comprising the whole width of the trunk, was received from the Director of Agriculture at Beira in October 1911.

A noteworthy feature of the specimen was the small

proportion of sap-wood present, the log consisting almost entirely of heart-wood, with about 1 in. of sap-wood on the outside.

The wood was yellowish light brown, varied by shade similar to that of satinwood and some of the sandalwoods, and in general character it resembled the latter. It was hard, close-grained, and filled with a reddish-brown resin; it burnt freely, and left very little residue. The wood had a bitter taste, and this may account for its immunity from the attacks of white ants.

The timber split easily but irregularly; it was difficult to saw and plane, but turned and polished well. Logs picked and cut for figure would make good veneers, and could be used for small fancy articles such as are made from olive wood. The wood weighed 60 lb. per cubic foot.

The British wood which this timber most closely resembles is box. The M'Zimbiti wood might be used for turning like box, for although it lacks the clearness of colour of the latter it is less brittle, and shows a figure, which box does not.

The wood was submitted to timber merchants, who obtained the following reports from two firms of commercial experts interested in this class of timber:

(1) The first firm considered that the timber would scarcely be a suitable substitute for boxwood, though, as it seemed to be very hard and close-grained they were of opinion that it might be of use in other ways, if the logs were sufficiently large and clean.

(2) The second firm reported that the wood could be used for various kinds of turnery, if it could be imported cheaply enough to compete with other woods of similar texture. They added that they were prepared to consider its utilisation if the price of the wood and the size of the logs were satisfactory.

TIMBER OF *TRIPLOCHITON JOHNSONII*

T. Johnsonii, C. H. Wright, is a lofty tree belonging to the Sterculiaceæ. It occurs throughout the evergreen and deciduous forests of the Gold Coast and Southern

Nigeria, and reproduces itself freely by seed, young plants springing up abundantly on recently abandoned farm lands. According to H. N. Thompson, *Report on Forests, Gold Coast, Colonial Reports, Miscellaneous Series*, No. 66 [Cd. 4993], 1910, the West African forests contain sufficient supplies of this timber to meet large demands in the home markets and in West Africa.

A sample of the timber from Southern Nigeria was received recently at the Imperial Institute and was submitted to a technical expert, who reported on it as follows:

The specimen submitted was sound throughout, and free from knots and sap. Little or no warping took place in samples which were cut and left for six weeks to test this point. The wood is of a light yellow-brown colour and of little decorative value, but it stains very well. It is light in weight (29 lb. per cubic foot), but is strong and fairly elastic.

Superficially this wood somewhat resembles a light-coloured mahogany, and for the imitation of mahogany it would be superior to American whitewood, being much firmer and stronger, and showing the mahogany-like pore marks which whitewood lacks.

The timber works easily with both machine and hand tools, which is an advantage, as many new timbers are costly in working. It is well adapted for glueing, and is soft enough to take nails well.

The wood is suitable for general joinery work and as a backing for veneers of more decorative materials. It also polishes well. It ignites readily, and is almost completely consumed on burning.

CRUDE PETROLEUM FROM MOROCCO

THREE samples of petroleum were received through the Colonial Office from the British Consul at Fez in July 1910. The samples were as follows:

No. 1.—" Mineral oil discovered in or near Ulad Aissa." This consisted of crude black petroleum containing 1·3 per cent. of water.

No. 2.—" Mineral oil discovered in or near Sherarda."

This was a mixture of water and crude black petroleum, the percentage of the former being 67·1.

No. 3.—"Mineral oil discovered in Sherarda Province at Ain Feriba." This sample also consisted of a mixture of crude black petroleum and water, the percentage of water in this case being 35·5.

All the samples contained some organic matter in suspension.

The oils were separated from the associated water, and were then examined with the following results:

	No. 1.	No. 2.	No. 3.
Specific gravity	0·853	0·874	0·876
Flash-point	78° C.	114° C.	120° C.

The results of distillation were as follows:

Fraction.	Boiling-point.	Yield by volume.		
		No. 1.	No. 2.	No. 3.
		Per cent.	*Per cent.*	*Per cent.*
Light petroleum	Below 150° C.	7	nil	nil
Kerosene	150° C. to 300° C.	70	47	43
Lubricating oil	Above 300° C.	23 [1]	40 [2]	53 [1]
Residue and loss	—	nil	13	4

[1] *Under* 15 *mm. pressure.* [2] *Under* 60 *mm. pressure.*

The kerosene obtained from sample 3 had a specific gravity of 0·836 and a flash-point of 98° C. (by the Abel-Pensky closed test). The kerosene fractions from samples 1 and 2 were too small to allow of similar determinations being made.

The above figures show that sample 1, as received, contained only a small amount of "light petroleum" and a moderately high percentage of "kerosene" or burning oil; whilst sample 2 contained no "light petroleum," but yielded nearly 50 per cent. of kerosene. Sample 3 was very similar to sample 2, except that the proportion of burning oil was somewhat lower.

A further sample of petroleum was received in February 1911, from the British Consul at Fez, through the Foreign Office. It was stated to have been obtained near Mazaria in Hejowa, about 30 miles north-east of Fez and within a few miles of the Jebel-Tselfats in Sherarda,

The sample, as received, consisted of rather heavy, dark brown, crude petroleum, mixed with half its volume of water.

The crude oil, after removal of the water, was examined with the following results:

Specific gravity	0·950
Flash-point	105° C.
Bromine absorption, *per cent.*	7·9
Sulphur „ „	1·70

The oil did not solidify at 0° C.

A portion of the sample was distilled in order to separate it into kerosene, etc. On heating, the oil evolved sulphuretted hydrogen, together with some unstable sulphur compounds, which deposited sulphur. The results of the distillation were as follows:

Fraction.	Boiling-point.	Yield by volume.	Specific gravity.	Flash-point.	Bromine absorption.
		Per cent.			*Per cent.*
Light petroleum	100–150° C.	1·0	—	58° C.	4·2
Kerosene	150–300° C.	30·0	0·911	81° C.	7·8
Lubricating oil	Above 300° C. at 100 mm. pressure	30·0	0·942	—	7·0
Residue	—	39·0	—	—	—

The "residue" was a thick, bitumen-like mass, which was too soft for use as the basis of an asphalt paving material.

The above results show that the crude oil under examination would be suitable for use as a liquid fuel, or could be distilled to yield a moderate quantity of "burning oil." It was, however, considerably inferior to the previous samples from Morocco, which yielded more kerosene and less bituminous residue than the present sample.

PETROL FROM TASMANIA

Extensive deposits of oil-shale exist south of Latrobe, in the Mersey district of Tasmania. The shale occurs as a seam 7 ft. thick, and extends over an area of 2,000 acres (see this Bulletin, 1912, **10**, 685). A sample of petrol distilled from this shale was received for examination at the Imperial Institute in September 1911.

The sample consisted of a pale yellowish oil having the characteristic odour of shale oil. It was examined with the following results:

Specific gravity	0·760
Flash-point	below 15·5° C.
Bromine absorption, *per cent.*	113

The sample was submitted to fractional distillation, with the results given in the following table:

Boiling-point.	Yield by volume.	Specific gravity.	Flash-point.	Bromine absorption.
	Per cent.			*Per cent.*
75° C. to 80° C.	0·3	—	Below 15·5° C.	—
80° C. to 100° C.	20·7	0·740	"	115
100° C. to 120° C.	47·0	0·758	"	112
120° C. to 150° C.	28·0	0·774	"	109
Above 150° C.	4·0	—	38° C.	—

The foregoing results are characteristic of the "naphtha" obtained by the distillation of shale.

It was not found possible to remove the somewhat strong odour of the sample by the methods usually employed for kerosene, without destroying the valuable low-boiling fractions.

This petrol would be quite suitable for use as a solvent, and for various other purposes to which petrol is applied. As regards its employment for internal combustion engines, it would probably be necessary to fractionate the oil, and use only the portion boiling below 120° C. for the purpose.

The following table gives the average results of the distillation of various well-known "motor spirits" obtained from petroleum (see *Proc. Incorp. Inst. Automob. Engin.*, 1908–9, **3**, 301).

No.	Boiling-point of fractions.					Original oil.	
	Below 100° C.	100° C. to 120° C.	120° C. to 133° C.	Above 133° C.	Loss.	Specific gravity.	Began to distil at
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
1	65·0	24·8	6·0	3·0	1·2	0·713	58° C. to 65° C.
2	66·6	23·9	5·0	3·1	1·4	0·717	60° C. to 65° C.
3	66·5	23·7	5·8	2·8	1·2	0·717	63° C. to 65° C.
4	39·0	49·0	7·5	3·5	1·5	0·739	70° C.
5	86·5	11·5	—	0·5	1·5	0·700	56° C.
6	73·0	17·5	5·0	3·0	1·5	0·705	55° C.

On comparing these figures with the results of the examination of the petrol from Tasmania it will be seen that the latter contained a larger percentage of high-boiling oil. The fraction boiling above 120° C. amounted to 32 per cent. in the Tasmanian petrol, whereas the maximum in the commercial samples is only 11 per cent.

CRUDE PETROLEUM FROM NOVA SCOTIA

A SAMPLE of crude petroleum from Nova Scotia was received for examination in February 1911. It consisted of a heavy black oil, floating on water.

A portion of the oil was submitted to fractional distillation, with the following results:

Fraction.	Boiling-point.	Yield by volume.
		Per cent.
Largely water	Below 110° C.	4
Kerosene	110° to 300° C.	56
Lubricating oil	Above 300° C. (under 30 mm. pressure)	12
Residue (bituminous matter)	—	28

The "bromine absorption" of the crude oil was found to be 8·2 per cent. The fraction boiling at 110° C. to 300° C. had the characteristic appearance and odour of the burning oil distilled from a crude petroleum containing a quantity of bituminous matter. It had a "bromine absorption" of 11·7 per cent., showing that a little "cracking" had taken place during the distillation.

The results of the investigation showed that this oil from Nova Scotia was a crude petroleum, containing a fair percentage of bituminous matter, and if the material is obtainable in quantity it would be of value as a source of petroleum.

SPECIAL ARTICLES

THE PROGRESS OF EGYPTIAN AGRICULTURE, WITH SPECIAL REFERENCE TO COTTON

By Gerald C. Dudgeon, F.E.S.

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Owing to the exceptionally well-organised administration which existed in ancient Egypt, and the zeal which its rulers displayed in recording their actions on stone monuments or by means of well constructed models, which the climatic peculiarities of the country have served to preserve rather than destroy, it is possible to picture clearly the rural life of the distant centuries, and to realise to what a small extent Egyptian agricultural methods have undergone change.

The Nile Valley from the most remote historical times has been renowned for its fertility, which is of a practically inexhaustible nature, due to the fact that whatever is taken from the soil by the crops of one year is replenished by the rich deposit left by the annual flood of the river wherever its waters are permitted to inundate the land. In addition to the enormous advantages which the inhabitants possessed from this perennial soil renovation, there is little doubt that, had they not been safeguarded to a great extent against foreign invasion by their extensive waterless surroundings, they would not have remained for long periods unhindered in the pursuit of their peaceful occupation of tilling the soil, nor have attained the relatively high degree of civilisation in early times which they did.

For centuries the cultivators of the valley grew the same crops, used the same implements for tilling the soil, and employed the same methods of irrigation as are in vogue in parts of the country at the present time, supplementing the watering obtained by the annual flooding of the basins by lifting water from the Nile during low-water

periods by means of hand-worked "shadufs,"[1] or cattle-driven "sakias."[2] It was, however, only upon small areas that these latter machines could be used, proximity to the Nile, or to one of the few artificial waterways which had been excavated, being essential; and, considered generally, the whole cultivation of the valley was dependent on the one inundation which the land received from the Nile flood. As the country is, for all practical purposes, rainless, it was only possible to obtain one crop each year from the flooded land. These conditions still obtain in all the districts to the south of Asyut, where canalisation has not been effected.

The whole of Upper Egypt was, until quite recently, under the basin system, but the Delta has for some time had the advantage of watering a large part of the cultivated area from broad canals mostly constructed in the nineteenth century. These canals were, however, for a long time unreliable, and gave constant trouble, yielding no regulated supply of water during times of the greatest need, and being dependent for their flow, previous to the perfection of the Delta Barrage, on temporary dams made in the Nile itself. Wherever flood or basin cultivation is still carried on, without supplementary water from "sakias" and "shadufs," the crops and the means of growing them are probably identical with those in use thirty centuries previously.

The basins are depressions in the alluvial banks of the Nile, which are lower than the river at flood period. They vary greatly in extent, and are supplied with water by means of leads from the river, which flow until the water-level in the basin is level with the river itself. The entrance channel is then closed, and the water in the basins, which attains a depth of one or two metres, is

[1] A beam working on a pivot, with a bucket attached to a rope suspended from one end and a weight at the other. It is worked by pulling down the rope until the bucket is filled with water from a low level, and permitting the weight to assist in lifting the filled bucket to a higher level, where the water is discharged.

[2] A vertical wheel with an endless chain of vessels running over the circumference, which are raised when filled with water by means of a bullock driving a horizontal wheel geared to the vertical one.

permitted to percolate, or run off after about forty days, so that the large amount of fertilising material, which is held in suspension in the flood water, may be deposited on the soil at the bottom of the basin. In cases where the flood supply is insufficient to cover all the basins with water direct from the Nile, arrangements have recently been made by which the whole of the water from one basin is not permitted to drain back into the river, but a part of it is discharged after some time into the neighbouring basins which may more urgently require it. In this way all the basins are now in receipt of water, and, although in the worst cases there is not much fertilising matter contained in that given to them, it is conceded that the impoverished water is better than none at all.

Basin cultivation commences as soon as the flood water has drained away and left the mud capable of bearing the weight of the sower. It is a common method to broadcast the various seeds of the "shitwe" (winter) crops on the still wet surface, covering them by means of the "ramroun," which is a rude type of harrow, chiefly made from palm-tree leaves. This system is termed "lok." More rarely the seeds are dibbled in holes, put in after a light ploughing, or covered by ploughing after broadcasting. This method is termed "hirati," and the resultant crops are usually superior to those where less disturbance of the soil occurs. The more important crops grown in the basins are wheat, lentils, beans, "gilban" (*Lathyrus sativus*), and fœnugrec (*Trigonella Fœnum-græcum*). The two latter are frequently used as a mixed crop, or are sown with wheat and beans. In the case of all these crops the roots penetrate the saturated soil at about the same rate as that at which the water recedes, enabling a harvest to be gathered in the spring or early summer without the application of further watering.

After the seed has been sown no attention is given to the land until the crop is ready for harvesting. The production of wheat is usually fair, and broadcasting has not yet been superseded by planting in lines or drills, whereby a cultivation of the land might be possible, and an even better crop be obtained. No weeding or hoeing

can be done in the case of the broadcasted crops, and it is not, apparently, a general practice to do more than break up the surface, when it becomes dry, in the case of beans. Ploughing just previous to sowing is regularly employed in those lands which are capable of being watered by "sakia" or "shaduf"; but in the past, as at present, such positions were used more especially for the cultivation of the sorghum millet, which is by far the most important summer crop, and requires light cultivation, manuring, and regular watering throughout its period of growth.

Such are the simple processes employed by the cultivators in the non-canalised areas, and thus, with a minimum amount of toil, have they gathered harvests annually in the same situations for many centuries, failing only in certain less favoured localities and upon rare occasions when the Nile flood was insufficient in volume to saturate all the land, or when it was too high and strong for the basin banks to withstand the force of the stream.

The methods of cultivation described above sufficed for the requirements of so many generations that the importance of improvements was lost sight of. Meanwhile, under more arduous conditions, agricultural methods became more and more perfected in European countries, far outdistancing those of Egypt.

Labour-saving apparatus was introduced in place of uneconomical methods, and agricultural knowledge in Europe increased while that in Egypt stood still. It is not difficult to realise that the agricultural procedure in Egypt, by long use, has become a part of the people themselves, so much so that, even with the altered conditions induced by improved irrigation and the introduction of new crops, the necessity of modification in accordance with modern requirements is rarely recognised. It had become impressed upon the minds of the cultivators, for instance, that the favourable conditions which had so long prevailed in Egypt were mainly dependent upon the beneficent Nile water, and the aim, therefore, of each successive generation of farmers was doubtless to get as much as possible of this commodity on to the land, to enable them to obtain more from it than the one annual crop which they could procure

from the flood watering. The possibility of applying too much water was a contingency hardly considered. Any abnormal condition induced by excessive watering, or even by the occurrence of an insect pest, was not attributed to natural causes, but was regarded as of supernatural origin, and therefore unable to be successfully contended against by human power. The same ideas prevail with a large number of farmers in Egypt at the present day, and have until quite recently constituted a formidable obstacle to progress.

Thanks to the extraordinary enterprise exhibited by one of Egypt's rulers (Mahomet Ali) about the beginning of the nineteenth century, in introducing, among other things, the cultivation of cotton and sugar-cane, and the wise administration of the British Agent-General towards the end of the same century, the country has prospered beyond all anticipation. Had it not been for the introduction of these new products, Egypt might have become at the present time of minor importance, and remained productive of little more, from its rich soil, than would support the needs of its own population. The success which has attended the extensive cultivation of cotton, which was only made possible by carrying out an enormous irrigation scheme, has altered the whole status of the people, and has made Egyptian arable land as valuable as any in the world.

On the introduction of the sugar-cane and cotton it soon became evident that no great areas could be planted without improved facilities for watering: neither crop could be successfully grown in the basins under the usual flood conditions, although cotton has been produced in a basin where dykes were erected and the flood water has only been permitted to enter in sufficient quantity to water the crop. In order to extend the cultivation of these two crops, it was apparent that many more canals were needed, and in addition that their flow should be properly regulated.

The employment of European engineers in the country in the early part of the nineteenth century marked the commencement of an organised irrigation scheme. This has been gradually improved until an adequate and reliable supply of water from the Nile has now become assured to the greater

part of Egypt. Not only has the originally canalised area benefited, but it has been enormously extended, and even the basin areas, where canals do not exist, have obtained advantages with regard to regular supplies at flood time. In order to effect this revolution in the water supply of the country, a large expenditure in energy and money was necessary in the planning and erection of regulating barrages, reinforcement of river banks, and the construction of main and branch canals throughout the new areas. Where basins have not yet been converted to canalised tracts, the improvements mentioned before have been made, so that those less favourably situated need not suffer as previously in a bad flood year.

One of the first steps towards the great scheme was the erection of the Delta Barrage at the bifurcation of the Rosetta and Damietta branches of the Nile, by means of which a head of water could be held up and discharged as required into the large canals traversing the Delta and originating from the Barrage. This Barrage, which was commenced in 1843 by French engineers and took twenty years to build, was unfortunately at first unsuccessful and, after remaining ineffective for some years, was eventually repaired under the direction of Sir Colin Scott Moncrieff and Anglo-Indian engineers between 1886 and 1890, with the result that it has been working efficiently ever since. Previous to the construction of the barrage it had been necessary to depend on the "sudds" or temporary barrages which were built annually across the two branches of the Nile, and which held up a limited quantity of water during the low Nile period. These "sudds" were washed away each year by the flood. Although the "sudds" are still constructed near the original places, there is now so little water allowed to flow in the Nile branches during low Nile, practically the whole being diverted into the canals, that what is held up by the "sudds" is chiefly water discharged from the drains or percolated from the cultivated lands.

The network of canals which gradually developed, especially through the Delta, necessitated the employment of a large staff of engineers, having a special acquaintance with irrigation. Salted lands were reclaimed by washing,

and the cultivable area of Egypt was increased. Water, which had been regarded by the fellahin as the chief need for cultivation, became plentiful, and was eagerly poured on the soil, especially at flood time, when it carried the valued fertilising matter.

In the case of cotton, a new crop in the country, the excess of watering had a harmful effect, but the fellahin attributed the damage to any cause but that of over-watering. The lessons which had been taught them with regard to the cultivation of cotton, and the special treatment of the soil for its growth, had at first been unwillingly learnt, but the desire for unlimited water supply, which has become a feature in the character of the fellahin, is being still more unwillingly forgotten.

Owing to the uncertainty of the water supply in the early times of the cotton-growing era, only a small proportion of the land could be adapted to it, but as the supply became more assured the area was increased and cotton appeared in the crop rotation, at first once in three years, and, more recently, twice within the same period. Most of the land was unable to renovate itself sufficiently quickly to maintain the crop twice within such a short period, and recourse had to be taken to manures to supply the deficiency of plant food.

Although in many cases the result of the frequency of cotton upon the same land is a diminution in the crop, still the margin of profit is so much higher than that obtained from any other crop that the frequency of its occurrence in the rotation is not likely to be lessened while the price remains high. As the recuperative power of the Nile deposit is apparently incapable of keeping pace with the exhaustion which now occurs in most of the Egyptian soils under the system at present employed, it may be found necessary shortly to make complete analyses of the different soils in Egypt with a view to supplying to each a chemical manure containing the requisite constituents in their proper proportion. Chemical manures are at present used in Egypt with little regard to this.

When cotton seed was expensive and watering had to be more carefully carried out in order to ensure the full

benefit being obtained, the seeds were put in at wide distances from one other, and as a consequence each resulting plant received a sufficiency of light and air for itself without encroaching on the domain of its neighbour. With increased facilities of seed supply and irrigation, the necessity for sowing seeds at such wide intervals and for specially preparing and preserving the water channels between the plants has been lost sight of, and it is customary at the present time to plant too closely and with little care of the interspaces. The result is the starvation of the roots of many plants, the lack of light and air, and the general deterioration of the crop. The close leafage forms an admirable protection to the insect pests which attack cotton in Egypt, and the increase of the severity of the periodical visitation of these during the last decade is a marked feature.

The area under cotton cultivation in the canalised districts of Egypt at the present time is about 40 per cent. of the total cultivated area in the same locality. Serious problems dependent upon this disproportionate cultivation are constantly arising. The diminution of the cultivation of food crops is the least important of these, as the profit yielded by a cotton crop more than suffices to pay for the importation of supplies to make up the deficiency. The effect on the soil itself is, as mentioned above, of great importance, and the deterioration of the quality of the cotton, dependent largely on too frequent and too close cultivation, is a prominent matter for consideration.

The quality of Egyptian cotton is the one feature in which it excels and upon which the industry has been enabled to attain such importance. There are, however, several kinds of Egyptian cotton, all possessing some degree of fineness, strength, and length of fibre, but differing in colour, silkiness, and other characters. These different kinds are frequently grown in adjoining fields, ginned in the same ginneries, and placed in so many positions, enabling their seeds to become crossed or mixed, that deterioration of the crop results. To maintain the position of the Egyptian varieties in the markets of the world it becomes, then, a matter of the first consideration

to keep them pure according to each type. From the fact that the people themselves are too slow to realise the supreme importance of this, it has become necessary for the Government to take steps to ensure that the purest and best seed of each kind shall be selected and supplied on the most favourable terms to cultivators. This work has been commenced by the Department of Agriculture, and the success with which it has been attended promises much for the future. The operations commenced, with the formation of the Department, in the distribution of the best seed procurable from the ginneries on credit to the small cultivators, and has now been extended to the distribution of specially selected seed grown on the State Domains Lands. This is sold to the larger and more careful cultivators under a contract by which the Government officers are permitted to inspect the fields where the crops are grown, and the cultivator agrees to furnish the name of the merchant to whom the cotton is to be sold, to enable the second generation of seed being followed up by the Department and kept pure for re-distribution.

Pure approved strains of cotton plants are meanwhile eing grown on the experiment farms of the Department, nd it is proposed that these shall be furnished, when a sufficiency is to hand, to the State Domains. In this way pure-bred varieties will be constantly produced, propagated with special care, and then distributed throughout the country.

Next in importance to the preservation of the unique quality of Egyptian cotton, the maintenance of the yield must be considered.

It is impossible to ensure the productiveness of any crop in any country, generally owing to variation in climatic conditions. In Egypt, however, the climatic conditions are fairly regular, and have less direct influence upon crops than in most other countries where rainfall plays such an important part. In an indirect manner slight climatic changes bring about great variations in the productiveness of crops, especially cotton. The insect pests, cotton worm (see this BULLETIN, 1912, **10**, 584), and cotton boll worm, which are directly responsible for the

loss of sometimes more than a million kantars of cotton in one year, are favourably influenced by dull, cool days. The eggs of the cotton-worm moth produce worms which survive readily if such climatic conditions prevail at their hatching, but which die in large numbers if hot and dry weather occurs at the same period. Thus a few days of weather favourable to this pest may make a vast difference in the cotton crop yield.

As mentioned above, the fellah has been accustomed to view a visitation of these pests apathetically, and is usually content to look upon the same as an incontestable action of "Allah," to whom he uncomplainingly leaves the responsibility of their removal even while he sees the whole of his crop being ruined.

The Government is compelled to legislate in order to save the cultivator's crop for his own benefit, and to expend a large sum of money each year to combat the attack.

A Commission has recently been formed to study the subject thoroughly, with a view to preventing the devastation in the future. The fact that stands out prominently with regard to both the cotton worm and cotton boll worm in Egypt is that there are coincident with them none of the parasites which are found to control them in other countries where they occur. The cotton worm, for instance, is a common insect in India, but in that country has never been observed as a cotton pest. It is infested there by certain internal parasites, which appear to multiply in accordance with the numbers of their hosts, and thus a natural balance is produced. The introduction of such parasites into Egypt might have a similar result. Meanwhile artificial means should not be disregarded, and until some less expensive and more effective method can be found, the practice of picking the egg-masses which is adopted by the Government should not be relaxed. In many other countries picking egg-masses is found to be the most expedient manner of combating certain insect pests.

The drainage problem is one which is constantly referred to with regard to Egyptian agriculture, and is occupying much attention at present. The want of efficient

drainage is more severely felt by such a crop as cotton than by other more shallow-rooted crops. No irrigation system in Egypt should have been adopted without an equal amount of attention being given to the removal of the water from the soil. In a large part of Egypt there is no natural drainage, such as is usually found in other countries where extensive irrigation works have been carried out.

What usually occurs upon land with inefficient drainage is that the cotton plants develop deep roots when the water table is low, and when this latter rises with the Nile flood these roots become asphyxiated, resulting in the fall of the flowers and bolls. The ideal condition of the plant would be a permanent water table, and, within certain limits, it is not necessary that this should be very deep. The plant will make its roots in accordance with the height of the water in the soil, and the tap-root will not develop to two metres in length if the water is present in the soil at one metre.

The chief obstacle with regard to drainage in Egypt is the low elevation of so much of the land, and the necessity of lifting the water from drains to higher levels, in order that it may flow by gravitation into the sea. Any drainage system would require the co-operation of every one within the area to be drained, or the undertaking of the lift by Government.

Owing to the low elevation of much of the land, the canals which supply water are mainly at a higher level, and are what are called "free flow," as distinguished from those which are at a lower level, from which the water has to be lifted.

The economy of free-flow canals with regard to most agricultural land is at once apparent, but in Egypt they have become a constant danger, from the fact that, when the cultivator is obliged to lift the water for his fields, he is unlikely to apply more than is necessary, whereas, where the water will flow without personal exertion, he is liable to take far too much. This is actually what occurs in practice.

The cultivation of sugar-cane has not met with the

same measure of success as cotton: the reasons being mainly that the profits from it are smaller and the land is occupied by it for a longer period, to the exclusion of other crops. As fast as the basin areas have been converted into canalised tracts, sugar-cane has given way to cotton, as the water from the Government canals is supplied free to the cultivators, whereas the water which was previously supplied by pumps on the Nile banks was controlled by the Sugar Company, and delivered at specially low rates to those people who grew sugar and sold the cane to the Company.

Sugar is well suited for cultivation and produces good crops in Egypt, besides being comparatively free from disease. The first improved cane was introduced from Jamaica, and constitutes what is now called the "Beladi," or country cane, having taken the name of an inferior kind which was grown previously on a small scale. During recent years one of the Java varieties, "No. 105," has been grown with success, and experiments have been made more recently with Mauritius cane. As far as has been at present observed no seed is formed on the Egyptian-grown canes, and the different varieties are therefore easily kept pure. In the Delta, sugar-cane is only grown for sale for chewing, and, as such, is a very remunerative crop when planted in the vicinity of large towns.

This brief description will convey some idea of the slow and difficult process by which Egyptian agriculture of the present day is being evolved, and by which the established methods of centuries are being moulded to conform with the requirements of altered conditions and new crops.

The means employed by the Egyptian rulers at the commencement of the last century to instruct the people was the use of the "Kurbash," and at the cessation of its use only a part of the lesson had been learnt. The remainder is being taught by a slower but equally effective method: that of combating mistrust by peaceful persuasion and the appeal to simple reasoning.

THE AGRICULTURE OF MOZAMBIQUE PROVINCE, PORTUGUESE EAST AFRICA

By R. N. Lyne, F.L.S.

Director of Agriculture, Ceylon; lately Director of Agriculture in the Province of Mozambique

The Province of Mozambique, to give the Portuguese territory in East Africa its correct name, extends through 16 degrees of latitude, and as about 4½ degrees of this lies beyond the Tropic of Capricorn, a very considerable part of its area must be classed as sub-tropical, suitable for the grazing of cattle and the cultivation of such crops as maize. This is the case with the administrative district of Lourenço Marques, now including Gazaland, which runs back to the Lebombo Mountains, on the Transvaal frontier. A large proportion of this is semi-forested, low veld that would pasture eight or nine head of cattle per 100 acres. In round numbers it may be stated that this territory could graze a million head of cattle, and that at present five per cent. only of that number is carried. Its great advantage over the high veld is that the native pasture does not fail in the cool season. One or two herds of Shorthorn and Friesland cattle have been established, and experience so far goes to show that heavy breeds thrive and cross well with the native cattle; Devons and Herefords might also be given a trial. Another important fact is that the whole of this district south of the Limpopo river has been cleared of East Coast fever, an achievement for which no little credit is due to the Mozambique Government and to Mr. Conacher, a veterinary officer of the Department of Agriculture, Union of South Africa, whose services were lent for that purpose. The grazing prospects of this sub-tropical part of Portuguese East Africa are thus seen to be very favourable, and there is no doubt that in time a great industry will be built up that will help to supply the markets of Europe with frozen meat.

The Sugar Planting Industry

Foremost among the growing industries of the country is that of sugar-cane planting, for which the magnificent river systems offer great facilities. The output of sugar in

1910 was over 30,000 tons, but it is safe to say that in 1914 this figure will be nearly doubled. The valleys of the rivers Inkomati, Buzi (in the Mozambique Company's territory), and Zambesi, which are proving the most attractive to sugar planters, are low alluvial plains which extend in the case of the Zambesi for a length of 150 miles. The estuaries are brackish to a distance from the sea indicated by the limit to which mangroves reach, usually some thirty miles, following the windings of the rivers (less than this in the case of the Buzi), and the neighbouring land is unsuitable for sugar planting. A margin above this should also be avoided, as the rivers are subject to serious periodic floods, the plains being converted into enormous lakes for a period of a month or more. The Limpopo valley is especially liable to inundations, and as a consequence has been hitherto neglected by sugar planters. Above the limit of serious flooding—in which description is not included submergence for three or four days only, provided there is no devastating torrent—the conditions for sugar planting are ideal, though search should always be made for the black alluvium the heavy, luscious canes require, and sandy outcrops avoided. The land slopes gently back from the banks, a characteristic feature with rivers of this type, and one very favourable for irrigation. The streams, though shallow, are usually navigable for shallow boats, the bars at their mouths being pierced by narrow channels. Water for irrigation is lifted by centrifugal pumps driven by fixed or portable engines.

The difficulties confronting the sugar industry of Natal, arising from the prohibition of imported Indian labour, are proving advantageous to Portuguese East Africa, the new enterprises in the latter country being financed to a considerable extent by Natal and Transvaal capital; but Mozambique has labour difficulties of her own, and the available labour supply is a matter every investigator should carefully examine before investing his capital.

The many kinds of cane cultivated fall into two groups: the one consisting of luscious green and purple canes of local or foreign origin, the other the hard Yuba, a variety discovered some years ago in Natal which is said to have saved the Natal sugar industry by its wonderful powers of

ratooning and of resisting drought, characters due to its habit of deep rooting. There are fields of Yuba on the Zambesi from which twelve or more ratoons per plant have been taken. It is probable, however, that on the rich alluvial plains heavy canes will oust Yuba, which is essentially a dry land cane.

Rubber

The Landolphia rubber forests represent the greatest agricultural asset the Province possesses. Including those of the Mozambique and Nyasa Companies' territories, their capital value is not far short of fifteen million pounds sterling. How best to exploit this rubber is the problem now engaging the attention of the Government, though it is agreed it can only be thoroughly done by private capital. Two methods of obtaining the rubber have been suggested: one consists in tapping the vines, the other in cutting them down and putting the stems through extracting machines for the separation of the rubber from the bark. By tapping the vines, it is maintained that they will be preserved throughout an indefinite period and be a continual source of income. No satisfactory method of tapping, however, has yet been discovered, that adopted by the natives, viz. "scarring" the trunk or slicing off pieces of bark, being destructive, as the operation is usually carelessly performed and a piece of the cambium is generally cut away with the bark. The vines are distributed so sparsely and irregularly that systematic tapping could not be properly supervised, and even if it could, it would scarcely pay an employer to have his men spending their time looking for tappable vines; nor, if the men were on piece-work, would it pay them to work systematically through wild forests. Left to themselves to tap where they please, we come back to the present wasteful system of tapper and merchant.

Those who advocate cutting down the trees and extracting the rubber by machinery argue that forests can be renovated by replanting or natural regeneration within a period variously estimated at from six to twenty years, but no Landolphia forest in East Africa has yet been renewed in this way, and hence no results can be quoted in support of this view, which is therefore purely speculative. It seems

very probable that the existing rubber vines have grown up with the forest and that only in the partial shade afforded by a young growing forest could the vines have attained their present size. If that is so, the cultivation of Landolphias is not a practical proposition, as no private capitalist would lock up capital for the time required to rear a forest.

After studying the question carefully, the present writer has come to the conclusion that the circumstances of the Landolphia rubber forests do not permit of their being managed as plantations, and that probably the only practical and profitable method of obtaining the rubber is to cut down the vines, extract the rubber by machinery, and utilise the land for new crops.

Ceara rubber is being established in the Quilimane district, where in the hinterland it thrives better than in any other district of the Province (see this BULLETIN, 1911, **9**, 390).

The southern part of the Province, *i.e.* south of the Zambesi, on the whole is too dry for Ceara rubber, the dry season being so long, and the period over which tapping operations can be carried on is, as a consequence, so restricted that there is not sufficient time for getting out a paying quantity of rubber. In Quilimane the annual rainfall is 60 in. or more, fairly well distributed throughout the year; the country is intersected with rivers and brooks, and the soil is fertile. The Ceara rubber plantations that have been formed look fresh and vigorous where they have been properly cared for, the trees yielding latex freely.

Oil-producing Plants

With a tropical coast-line of close upon 1,000 miles in length the Province might be expected to offer rich possibilities for coconut planting; but dry sand-dunes, on which nothing but the scantiest herbage will grow, monopolise the greater part of this belt. There are redeeming strips in Quilimane, and to a less extent at Inhambane, but not even the best of these can be described as first-class coconut land comparable with that of Zanzibar, for example. Nevertheless much enterprise is being shown at Quilimane by the various Prazo companies, who are going in for

extensive new cultivation. The drawback there is that the hard and dry coconut soils are cut into by swamps, through which costly drains have to be cut. These drains are not all kept working, and some become choked with weeds, so that stagnant water accumulates round the roots of the palms. As a result the palms become unhealthy, and the plantations abound in mosquitoes.

Trichilia emetica, known locally as "mafureira," the seeds of which are the source of mafura tallow, occurs abundantly at Inhambane (compare this BULLETIN, 1903, **1**, 26; 1908, **6**, 376; 1912, **10**, 315). The Trichilia belt extends for some 250 miles, but this enormous natural wealth remains almost entirely neglected, only about 1,000 tons of seed being exported annually, representing some 2 or 3 per cent. of the total crop. As is the case for many natural forest products, the price offered for the seed is scarcely sufficient to tempt the native villager to collect the seed or the European to organise an export industry in this product. Transport in the country is particularly difficult, there being no railways or metalled roads; and the soil being sandy, the roadways become cut up into sandy tracks too heavy for wheeled traffic. It can scarcely be doubted that the mafureira industry of Inhambane is destined in time to be taken in hand by some enterprising firm.

Mozambique ground nuts are of excellent quality, but it will not repay the employer of labour to cultivate them. The industry is solely in the hands of natives, large quantities being produced in Quilimane for payment of the tax collected in kind by the Prazo companies.

Telfairia pedata, jikungu, or mkweme, as it is called farther up the coast, flourishes in Inhambane; but the kernels, though rich in oil, cannot yet be utilised in industry (see this BULLETIN, 1912, **10**, 223).

Sisal Hemp and other Fibres

This plant grows from one end of the Province to the other, and there is no part of East Africa where the cultivation of Sisal hemp offers such good prospects as in many places in Mozambique. Water—running water, if

possible—is an indispensable requirement for a factory extracting Sisal hemp. The factory should be placed on the bank of a river, so that the stream can be tapped higher up and running water led through in such a way that the pulp falls into an open drain and is carried direct to the river. On the assumption that 3 per cent. of fibre is obtained from fresh Sisal leaves, the production of 3 tons of fibre would necessitate the moving of 100 tons of leaves as well as 97 tons of refuse. By arranging that running water removes the pulp the producer is relieved of the expense of handling this 97 tons of waste and the cost of working is considerably reduced. The soaking tank also should have water running through it. In a country so magnificently served with rivers as is Mozambique there should never be any difficulty about obtaining these conditions. Sisal does best in a dry soil and climate, the percentage of fibre, a very important point with such a bulky crop, being likely to be higher with conditions on the dry side, as in those of Portuguese East Africa. Those who contemplate planting Sisal should study carefully the modern type of self-feeding and reversing decorticators.

Sisal grows on the banks of the rivers that flow into Delagoa Bay, but that part of the Province is only just within the Sisal belt. The soil and climate of Inhambane suit it well. On the banks of the Sabi, in the Mozambique Company's territory, a new plantation is being opened, while in the Quilimane District there are three plantations: one on the banks of the Shire, and two belonging to the Boror Company and aggregating 2,500,000 plants, on the river Inhamiara. A sample from one of these, the Malinguini estate, was favourably reported on recently by the Imperial Institute (see this BULLETIN, 1912, **10**, 131).

Furcræa gigantea, Mauritius hemp, can be grown over a greater range of latitude than Sisal. It is cultivated in the Inhambane District, where difficulty has been experienced in obtaining plants of Sisal; and a Furcræa plantation has also been opened near Lourenço Marques. The percentage of fibre in Furcræa is appreciably less than in Sisal (compare this BULLETIN, 1910, **8**, 270), and it is unlikely that Furcræa will prove popular in the Province.

Phormium tenax, New Zealand flax, would probably suit the low, marshy river flats of the southern extremity. It has the advantage over Sisal of being free from spines, and therefore an easier crop to handle. It yields up to 12 per cent. of fibre, and, once established, will continue for years, closing up its ranks and requiring no weeding.

Cotton

Cotton has as yet made no headway in Portuguese East Africa. Some years ago the Oceana Company made extensive trials on the Sabi with Egyptian cotton, but abandoned the enterprise after sustaining considerable loss. Egyptian cotton has not been entirely satisfactory in any of the East Africa Protectorates, and in Mozambique has been a failure. There the dry season is the cool season, and the cotton is planted in "autumn," not in spring, as in Egypt. Long-staple, improved American Upland, which is proving so successful in Nyasaland, is manifestly the type indicated, and trials have already been made with it on the banks of the Shire—without, however, as yet, any conclusive results. The question of climate has not been sufficiently studied, and so it is impossible as yet to say where, if anywhere, cotton can be successfully grown in Portuguese East Africa.

Tobacco

One of the most profitable industries in Nyasaland at the present time is that of tobacco planting, but this product has not yet received the attention it deserves at the hands of the Portuguese Government. There is no reason to suppose that the successes of Nyasaland and Rhodesia could not be repeated in many parts of Mozambique. Inharrime, south of Inhambane, is now the principal tobacco-growing centre, the industry there being principally in the hands of Greeks, who produce what is in fact little better than Kaffir tobacco, that manufacturers in Europe would not look at. The market is the town of Lourenço Marques and the Transvaal.

Air-curing is at present employed, but no great industry, such as that now growing up in Nyasaland, is likely to become established until flue-curing is adopted

with American types of tobacco, and for this the services of a tobacco expert should be engaged, and the co-operative system of curing and marketing started among small producers. A beginning could be made at Inharrime, where the soil and climate are well suited for tobacco. The local markets, though they can keep a few small settlers going, could not absorb any great quantity of tobacco, especially of fine grades.

The Zambesia Company is building flue-curing houses on their estate at Bompona on the river Shire, and planting American types of tobacco principally, though trials will also be made with Turkish, Sumatra, and Cuban tobaccos. These are the first flue-houses to be built in the Province, and the Zambesia Company deserves credit for the enterprise they are showing. It is an example that, it is to be hoped, others of the great Prazo companies will follow. Tobacco is also produced in Tete, but this somewhat inaccessible district, three weeks or a month from Chinde when the Zambesi is low and navigation restricted to house-boats, is not yet likely to attract settlers in any numbers.

Quilimane

Quilimane deserves special mention because not only is it the most fertile district in the Province of Mozambique, but also in the whole of East Africa, as far as the writer's experience goes.

The map shows many rivers between Cape Delgado and the Zambesi, but most of these are but dry water-courses except in the rainy season, when they become rushing torrents. Quilimane, however, is traversed by eight or ten considerable rivers, flowing with abundance of water throughout the year, and in addition the country is intersected with innumerable running streams. Quilimane possesses this first essential of successful agriculture, namely, a good river system in an unparalleled degree as far as East Africa is concerned. Behind the coconut belt stretches of rich argillaceous swamp bottoms are met with, destined to be drained and to come under sugar-cane. The country rises gently from the coast, and as soon as

the sugar-cane land is left, forest loams are encountered, varying in quality but never poor. On these, rubber, fibres, fruit, cocoa, vanilla, and tobacco would flourish, as already stated. The annual rainfall is about 60 in., and is well distributed; near the Nyasaland border it is probably more, and the climate is not unhealthy as African climates go.

To conclude, Mozambique is the country of the syndicate and the steam plough, and in only two places has close settlement yet been attempted. One of these is Namahasha, on the Lebombo Mountains, near the Transvaal, the other Macequece, on the Beira railway, close to Rhodesia. Two or three farmers are settled on the banks of the Umbeluzi, catering for the Lourenço Marques market in fruit, milk and lucerne; but half-a-dozen farmers could easily supply these local demands. The Transvaal already sends fruit and milk to Lourenço Marques, so it would seem that the Johannesburg market is not likely to afford a profitable outlet for surplus stock from Delagoa Bay. Furthermore, it seems likely that under prevailing conditions, sugar-cane would pay better. Maize growing is in the hands of the natives, and is likely to remain so.

THE POTTERY INDUSTRY OF ILORIN, NORTHERN NIGERIA

By Dr. J. W. Scott Macfie

Medical Officer, Ilorin, Northern Nigeria

Before European traders introduced foreign crockery and enamelled ware into Nigeria the natives had to rely on their potters to supply all the ordinary household utensils; for metal vessels are comparatively rarely met with, being too costly for the common people, and calabashes, although grown in a great variety of shapes and sizes, and even provided with natural necks, are not suitable for all purposes. Native pottery is still, however, generally preferred to European substitutes, which are unfamiliar and expensive, and moreover are often ill-adapted for native use. The water-pots used by the women at the wells, the little

PLATE I.—RED POTTERY.

FIG. 1.—A potter's compound. Women making large water-pots, and preparing clay.

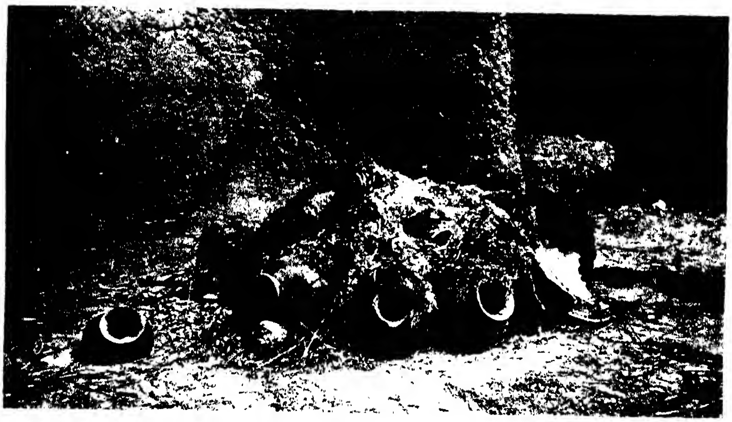


FIG. 2.—Firing the pots

FIG. 3—A corner of a potter's compound.

Adding the rim to the vessel

PLATE III.—BLACK POTTERY.

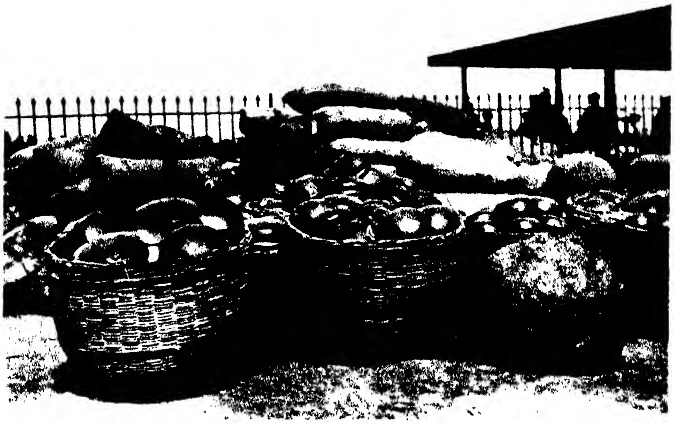


FIG. 1.—Baskets full of pottery waiting to go by railway into Southern Nigeria.

FIG. 2.—Woman finishing a dish.

FIG. 1. RED POTTERY.

A large water pot, height 17 in., diameter of mouth 7 in.

FIG. 2.—PAINTED POTTERY.

Ornamental lamp: a typical example of this ware. Decorated with the figures of two antelopes, two guinea-fowl, and, in the centre, a bird in its nest: painted in blue, black and magenta, on a white ground.

PLATE V.—BLACK POTTERY.

FIG. 1. Pots laid out for sale, and others, not yet burnt, inverted and drying in the sunshine.

FIG. 2.—Firing the pots.

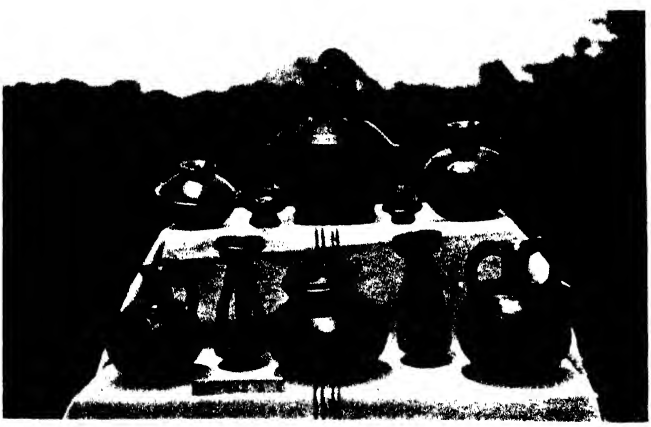


FIG. 3.—Typical examples of the ware.

PLATE VI.—PAINTED POTTERY.

FIG. 1.- The potter and two of his vessels. The latter are being dried in the sunshine before being burnt.

FIG. 2. The potter at work.

horseshoe-shaped grates for cooking, the moulds for *agidi* (a favourite native food), and all the larger vessels, such as the great pots in which water is stored, and the vessels for brewing *pito* (the native beer) and melting shea butter, are of native manufacture. The great majority of the cooking-pots, dishes, and bowls for food are also of the same wares; and ewers, cruises for oil, lamps, and ink-bottles of native pottery are in common use. A few purely ornamental vessels are also made, such as the painted ware of which illustrations are given (Plate 4, fig. 2; Plate 6, fig. 1). Others, such as the curious pot in the middle of the top row of the examples of black pottery seen in Plate 5, fig. 3, have superstitious significance. Parents who wish to have children place such a pot in one of the little *juju* huts so common in the native towns. Pebbles gathered from the river-bed are placed inside it with a little water, and, a fowl having been sacrificed, its blood is poured over the top of the pot.

Ilorin, the largest city of Northern Nigeria, and the headquarters of the province of the same name, is situated on the Nigerian railway at a point 246 miles from Lagos, and 59 miles from Jebba. The city is 9 miles in circumference, and is estimated to have between 30,000 and 40,000 inhabitants, but this number is augmented during the dry season by a floating population of many thousands. Quick to avail themselves of the means of rapid transport afforded them by the railway, the natives not only travel freely up and down the line themselves, but also make use of it for the distribution of their goods. Amongst other exports great baskets full of the pottery made at Ilorin may be seen almost any day of the week at the railway station waiting to go south to Lagos, and north, at any rate as far as Zaria (Plate 3, fig. 1). It was this sight that led the writer to enquire into the native industry, and to take the photographs reproduced in the present article.

Two main varieties of pottery are made in Ilorin, which for convenience may be designated respectively "red" and "black." Although there are isolated compounds within the walls in which pot-making is practised, the potters, who are invariably Yoruba women, congregate mostly in

one district of the town, viz. that to the north-west. The makers of the red pottery and the black both inhabit this quarter, but, although there is a tendency for two or three neighbours to be occupied as manufacturers of the same variety, there is no sharp separation of the two classes.

Only the women make pottery,[1] and only certain families are employed in this industry. The writer was unable to discover any traditions relating to its introduction, or any reason why the work should be restricted to women; enquiry was invariably met by the assertion that the potter had been brought up in the business by her mother, who in turn had learned the trade from her mother. The shapes of the pots are similarly established by long usage, and, for the most part, each potter limits herself to the making of one or two forms. Certain of the types are undoubtedly derived from the calabashes and gourds that abound all over the country, and are used for many purposes instead of vessels of clay. The makers of red pottery are quite ignorant of the processes employed by the makers of black pottery, and *vice versa.*

Red Pottery

The commonest variety of pottery in Ilorin is a red ware, often rough, with but little decoration, and "varnished" only over the upper portions. Several qualities are made; some very coarse, of a mottled red colour, unglazed and unornamented, such as the little bowls used as moulds for *agidi*, a sort of native blancmange; others carefully smoothed, of a fine red colour, and covered with simple ornamentation. Of such ware are the large water-pots,

[1] In northern Africa also the potting industry seems to be largely in the hands of women. In Algeria, for example, Prof. van Gennep observed that Kabyle pottery was the work of women (A. van Gennep, "Études d'Ethnographie Algérienne," tirage à part de la *Revue d'Ethnographie et de Sociologie*: Paris, Ernest Leroux, 1911, p. 13). MacIver, however, notes that "it is only in Nubia that women are the potters; elsewhere in Egypt the master-potter is always a man, and if the women take any part in the work, their share is confined to the burnishing and decorating" (D. Randall MacIver, "The Manufacture of Pottery in Upper Egypt," *Journal of the Anthropological Institute*, 1905). It is not the writer's intention in this paper to deal with the interesting ethnological questions arising out of these observations on the pottery industry of Ilorin, but this opportunity may be taken of referring those interested in the subject to the admirable treatise by Prof. van Gennep mentioned above.

the household utensils, and the horseshoe-shaped grates used for cooking. The initial stages in the making of pottery, whether it be the red or black, seem to be similar, and it will be convenient to describe them here, taking as a concrete example the evolution of a simple hemispherical pot such as that which Senabu, an old Yoruba woman, the head of a family of potters, made in the presence of the writer.

The various appliances referred to may be distinguished in Plate 1, fig. 1, where the potter herself is seen in her own compound superintending assistants who are building up large water-pots. The potters work in the open air under the shade of a tree, and surrounded by a number of large vessels containing the materials—water, earth, and *wia*, of which to make the paste, and prepared paste carefully covered by a damp cloth. Scattered here and there are smaller dishes containing "locust-bean" extract, emulsion of *lentana*, etc. (Plate 1, fig. 3; Plate 2). In another part of the compound, or somewhere close at hand, is the open space in which the pots are burnt, and some of the neighbouring huts are set aside as store rooms, where row after row of the finished ware can be seen.

Squatting on the earth, Senabu prepared a small patch of ground before her, sweeping it clean with a brush of twigs and dusting it over with ashes. On this she dumped a lump of grey-coloured clay, and rising, trampled it with her feet until it was of the requisite size and thickness. With this cake of clay she fashioned the base of a vessel, moulding it over the bottom of an old pot which had been carefully powdered with ashes, and beating it, first with a flat stone, and then with a slipper-shaped piece of wood, until it was spread evenly over the surface. Then, dusting the clay with ashes, she lightly sprinkled it with water, and smoothed its surface with her moistened hands. The pot was then ready to receive the simple decoration customary on such ware. By rolling a short plait of wet cord round the pot with her fingers, Senabu imprinted a band as wide as the full length of the plait (about 3 in.) midway between the bottom of the pot and its ragged edge.

With a twig she smoothed down all excessive roughnesses that occurred in the band, indented two circles at its lower edge by means of her forefinger covered by a damp cloth, and finally, using a small stick, traced a zigzag line over its full width. The base of the pot thus fashioned was gently lifted off the mould and laid aside to dry.

When sufficiently dried the base is laid, concave side upwards, on a surface of sand or earth contained in a shallow calabash, which rests on the top of a large pot, and the rim is added (Plate 2). In doing this the potter stands over the vessel and works gradually round its circumference, moulding on the rim with the fingers of her right hand whilst supporting the outer surface with the palm of her left. In the case of larger vessels such as water-pots, two or three successive zones of clay are added to the base, the clay of each zone being allowed to dry before the next is added, the rim being the last (Plate 1, fig. 1). Nothing in the nature of a potter's wheel is in use at Ilorin.[1] The outer surface of the upper part of the vessel is next carefully smoothed and allowed to dry in the sunshine for a day. Before being burnt the pots, which are then light grey, are smeared with a watery paste to give them their red hue. Pots of a poor quality are smeared with moistened ferruginous earth,[2] which imparts to them a rusty colour, but for the better qualities triturated *lentana* (a red stone brought from French territory west of Sokoto, out of which also beads and other personal ornaments are cut) is used, which produces a richer red. [This *lentana* is a red, earthy ironstone of the type commonly called laterite. It is somewhat porous, but fine in texture, and free from grit or sand.—ED.]

The pots are fired in heaps (Plate 1, fig. 2) with dry grass, being separated from one another by fragments of pottery, and surrounded by a circle of old pots, an arrangement that may be considered to indicate the dawn of the

[1] In Southern Nigeria, however, a rude substitute for a wheel is in use. See John Parkinson, "Notes on the Asaba People of the Niger," *Journal of the Anthropological Institute*, 1906; and N. W. Thomas, "Pottery-making of the Edo-speaking Peoples, Southern Nigeria," *Man*, 1910, No. 53.

[2] In Upper Egypt MacIver notes that "the use of the hæmatitic coating is distinctly Nubian" (D. Randall MacIver, *loc. cit.*).

idea of an oven. After about six hours they are removed, and, before being finally disposed of, are smeared over with an aqueous extract of the pods of the locust tree,[1] a kind of "varnish" which gives them a shiny surface. In the foreground of Plate 1, fig. 3, a piece of *lentana* is seen lying on the stone on which it is rubbed down into a powder, also a bowl of the emulsion of *lentana* with water, a larger pot containing the extract of the pods of the locust tree, and the bundle of leafy twigs with which the liquids are applied to the pots.

The clay is dug out of shallow holes in the ground, and is intimately mixed with a white, gritty powder called *wia* [this consists essentially of felspar.—Ed.]. In Plate 1, fig. 1, a girl is seen pounding a lump of clay with a large wooden pestle. The clay as used in making the pots is of a dull grey colour.

Red pots are made in a considerable number of shapes and sizes, some of which are seen in the accompanying illustrations. Their dimensions vary from the toy vessels 2 or 3 in. high made for children, to the large water-pots, many of which stand 24 in or more, and have a diameter across the mouth of 18 in. The commonest form is the simple hemispherical pot with an everted rim, and these are made in a great variety of sizes. As a rule only the upper third of the pot is bright red, smoothed, and "varnished," whilst the lower two-thirds are rough and dull red in colour. Large water-pots are made either with or without necks, and the former, being the more difficult to make, and often simply decorated, naturally command a higher price. Comparatively few of these red pots are

[1] "'Doriwa' or 'dorowa' (*Robinia pseudacacia*), a tree resembling an acacia, called in America the locust tree" (*Dictionary of the Hausa Language*, by Charles Henry Robinson, 1906, vol. i. p. 46). But in the appendix to the same volume, in the "List of Plants with Hausa names and botanical identifications," by Dr. Dalziel, "dorowa" is identified as *Parkia filicoidea* (Leguminosæ).

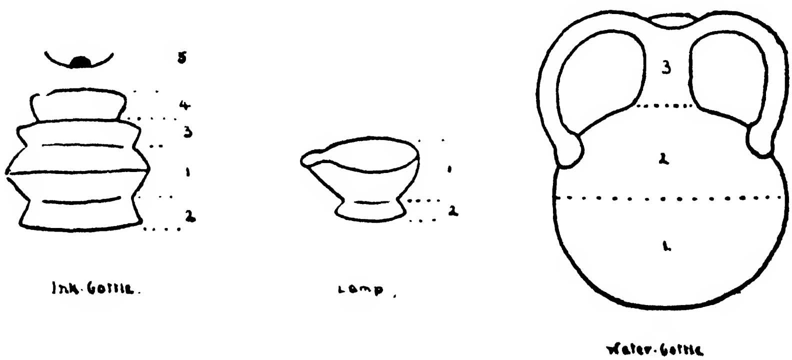
[The "locust tree" of Northern Nigeria is undoubtedly *Parkia filicoidea*. The pods have been analysed at the Imperial Institute and shown to contain a large amount of mucilaginous matter soluble in water. This would be extracted by water, and the extract, when applied to pots, would be fairly permanent in a dry country such as Northern Nigeria, but would gradually disappear in use in a humid climate.—Ed.]

ornamented, and the decorations, when employed, are of the simplest, as a rule merely one or two indented lines round the shoulders of the vessel to mark the lower limit of the "varnished" upper areas, or roughened bands rudely scored with zigzag patterns (Plate 4, fig. 1).

Black Pottery

The makers of black pottery are also Yoruba women, living for the most part in the north-west district of Ilorin, and the art is handed down in certain families from generation to generation. Nor could any history or tradition of the introduction of the industry be obtained. In each compound a single form of vessel is produced, or, at most, two or three forms.

The initial stages in making a black vessel are identical with those described above in dealing with red pottery, and the clay appears to be similar. First the base of the vessel is made and partly sun-dried, then the rim or top is added and the whole again exposed in the sunshine to dry. Plate 3, fig. 2, shows a woman adding the rim to such a base, whilst to her left lie several drying dishes. The more elaborate vessels are made in several stages, as is indicated in the following diagram by means of numerals



so placed as to mark the various stages of the building up. The body (1) of the ink-bottle, for instance, is the first piece to be moulded, and to this are added successively the foot (2), the shoulder (3), the neck (4), and finally the lid (5).

When nearly dry the greyish-white vessels are carefully polished by rubbing with a round and perfectly smooth pebble until a fine surface is produced. They are then

exposed in the sunshine once more until they are completely dry. In Plate 5, fig. 1, a group of vessels thus exposed is seen; they may be distinguished from the completed pots laid out for sale by their white colour.

When dry the pots are burnt in heaps (Plate 5, fig. 2). In this case damp grass is employed and the black colour of the vessels is chiefly due to the permeation of the ware by the smoke. Firing takes twelve hours or more, the heaps being ignited in the afternoon and left undisturbed until the next day. Finally the pots are removed while still hot, dipped twice in an aqueous extract of the pods of the locust tree, and set aside to dry. A fine black colour with a brilliant lustre is thus obtained.[1]

A great variety of shapes is made, some of the commoner of which are illustrated in Plate 5, fig. 3. One curious form used to dry meat is not, however, shown; this is a wide-mouthed vessel fitted with a lid pierced by a great number of little holes. Many of the vessels are without decoration, others have simple patterns traced round them—deep bands of zigzag lines, circles and rows of dots,

[1] In the Ridyard collection at the Liverpool Museum there are a number of examples of West African pottery, including specimens, brought from the Gold Coast, of both red and black wares. The vessels are for the most part more highly finished than those collected by the writer in Northern Nigeria, and seem to indicate a more advanced stage of development. The writer is indebted to Mr. P. Entwistle, of the Liverpool Museum, for the following notes by Mr. A. Ridyard on the manufacture of pottery at Oblogo, Gold Coast Colony, from which it will be observed that the processes differ considerably from those in use at Ilorin:

"The pots are made from a local clay. The clay is mixed and allowed to stand in a cool place for two days. The pots are then worked up by hand on a piece of board and smoothed with stones; when made they are allowed to stand in the sun for three days to harden before firing.

"They are then placed in a conical fire made of sticks placed on end with a bed of dry grass. Several pots are fired at once, each being kept separate. They are fired for exactly forty minutes and are then found to have burnt red. If it is desired to finish the pot in this condition it is allowed to cool, and is then coated with a thin paste of a special red clay obtained from the gold district in Ashanti and polished with pebbles.

"Should the pot be required to be finished black, it is taken out of the fire after forty minutes burning and at once placed in a bed of leaves for twenty minutes, being kept constantly moved to allow the blackening process to be effective on all parts; at the end of this time it is found to be completely blackened. The black can be polished with the pebbles as in the red stage. Care is taken to keep the leaves from firing by damping if necessary. The whole of the operations are protected from the wind during firing and smothering, or smoking, the pots being constantly turned by means of a stick."

or radiating streaks that scarcely indent the surface, but are conspicuous in certain lights. Such patterns as these are traced after the surface has been smoothed with the pebbles and before the pots are burnt. The black pottery is greatly prized by the natives, as is indicated by the fact that it is carried all over the province heaped up in loads on the heads of women, and that by railway it reaches down to the seaboard at Lagos, nearly 250 miles distant, and northwards at any rate as far as Zaria, some 376 miles beyond Ilorin.

Painted Pottery

A third variety of pottery is occasionally met with in Ilorin, of which the lamp illustrated by Plate 4, fig. 2, is a typical example. These ornamental vessels, often of elaborate design, decorated with the figures of birds and animals, and painted in gaudy colours, are the work of a single potter, a Hausa man. Although this ware is evidently not native to Ilorin, it may be of interest to include here a short account of the manufacture of these remarkable vessels.

After some little difficulty the writer succeeded in tracing the maker of the painted pottery, and visited him for the purpose of taking the accompanying photographs. His compound was situated on the western fringe of the town, close to the caravan road, and apart from the other potters, the women who make the red and the black wares. There were one or two pots laid out on the ground to dry in the sunshine (Plate 6, fig. 1), and the potter himself was working at a lump of clay in the shade of a little mud hut. He was a Hausa, a native of Goja, but had been living in Ilorin for a number of years. He said he had learned his art from a fellow-countryman at Lokoja, and that although he was the only man in Ilorin who could make these pots, a great many men were employed in similar work at Kura, near Kano.

In Plate 6, fig. 2, the potter is shown at work before his house; it should, however, be stated that under ordinary circumstances he worked under cover, but that on this occasion he had brought his tools and paint-pots into the open air on purpose to be photographed.

The clay, *yimbu*,[1] he used was of a bluish colour and of a gritty character; it was procured, according to his account, from a hole in the ground on the road to Sobe, and mixed with horse-dung before use. Taking a lump of this moist clay, he rolled it between his hands and then flattened it out with his palm on a mat at his side, on which he had strewn a gritty grey powder consisting of felspar, also called *yimbu*. Then, lifting the flat cake, he pressed it down over a wooden mould, to shape it into a lamp bowl. When he had pressed it evenly over the surface he took a thin strip of iron and, running it quickly round the mould, cut off the lower ragged edge of clay. The powder evidently prevented the clay from adhering to the mould, for he was then able to lift off the bowl and lay it aside to dry. Large vessels decorated with the figures of birds and antelopes, which are his speciality, are made in many separate pieces which are partly dried and then joined together before the whole is fired.

After being moulded the vessels are laid out to dry in the sunshine for a day. Their surfaces, after having been rubbed smooth with a string of beads, the seeds of the "Kuka" tree (*Adansonia digitata*, the baobab), are painted with a pink paste, *bakua*, made by grinding down a soft pink stone with water. The vessel is then laid on a layer of sticks and covered with dry grass for firing. Finally it is painted. The potter had four pigments in little dishes, in each of which was a small feather to apply the paints:

1. White, *alli*.[2] Obtained by powdering calcined bones.
2. Blue, *shuni*.[3] The same colouring matter as is used to dye cloths.
3. Green. A crystalline dye of European manufacture bought in the market.
4. Red, *garura ja*.[4]

[1] "'Yimbu,' 'yambu,' clay, mud." *Dictionary of the Hausa Language*, by Charles Henry Robinson, 1906, vol. i.

[2] "'Alli,' chalk or white earth used for bleaching thread," *ibid.*

[3] "'Shuni' or 'juni,' blue colour, indigo," *ibid.*

[4] "'Garura,' a red dye, brought as a powder from the East"; "'*ja*,' pl. 'jajaye,' red," *ibid.*

The pigments are mixed with *karo*[1] (obtained from a tree called *mareji*) in order to make a suspension to paint over the vessels. The potter was particular in insisting that the paints should be applied in the order given above. The whole vessel receives a preliminary coat of white, after which the decorations are added—first the blue, then the green, and lastly the red. He sometimes uses also a black pigment made from soot. When the pot is painted it is allowed to dry, but is neither glazed nor fired again nor otherwise further treated. The decorations tend, therefore, to be smudged or obliterated by handling.

Prof. Ure has pointed out to the writer that vessels such as that shown to the left of the potter in Plate 6, fig. 1, offer an interesting parallel to some Greek vases identified by Bosanquet, Kourouniotes, and others as *kernoi.* Prof. Bosanquet,[2] indeed, alludes to the possibility that these vessels may have been used as lamps as perhaps worthy of consideration, but they appear to have been accepted as *kernoi* by later writers. The Greek κέρνος "was a clay vessel, to which were attached a number of small cups containing various grains and liquids, offered as first-fruits of the harvest, especially in the Eleusinian worship."[3] There is reason for believing that lights were placed upon the *kernos*, and were an essential part of it. The evidence is quoted by Xanthoudides,[4] who points out that the use is perpetuated to this day in the rites of the Orthodox Greek Church.

The bowls on the Nigerian vessels are explained by the natives as lamps, and in the specimens seen by the writer at Ilorin, a shallow indentation or lip for the wick was invariably present on the rim. It is difficult, however, to believe that such vessels could be commonly used as

[1] "'Karo,' 1. a kind of gum put in ink; 2. 'karon maje,' a sort of gum drawn from a tree and used for perfumes," *ibid.*

[2] R. C. Bosanquet, *Annual of the British School at Athens*, No. III. p. 59.

[3] S. Xanthoudides, "Cretan Kernoi," *Annual of the British School at Athens*, No. XII. p. 9. References to other papers on this subject will also be found here.

[4] *Annual of the British School at Athens*, No. XII. p. 19: see especially the scholiast on Nikander; "'kernoi' are the mystic kraters on which they set lamps."

lamps, and in fact the writer was led to understand by the natives that they were mainly ornamental. Several examples of these vessels are included in the Ridyard collection at the Liverpool Museum which are said to have come "from Lokoja, Burutu, Baro, and Bida, N. Nigeria," and it is interesting in this connection to note that in them the bowls are without lips, and have therefore lost their distinctly lamp-like form. In one specimen, indeed, the bowls, which are constricted at the mouth, have distinct shoulders, and the edges are extended and flattened into flange-like rims. The changes in the form of these lamps suggest perhaps that in Nigeria at the present day a development is taking place from one use to another. This again suggests the possibility that the vases published by Bosanquet, Xanthoudides, etc., may have developed from lamps by the differentiation of the bowls so as to serve as receptacles for offerings, "the subsequent multiplication and consequent modification of the cups" being explained, as suggested by Prof. Bosanquet, "by the tendency of barbaric art to magnify and elaborate simple articles for the sake of display, and without any regard to practical convenience."[1]

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

SOME COMMON SPICES

It is sometimes stated that commerce in spices is no longer so important as formerly, but this is only true in the sense that the industry is now not restricted to a few centres of cultivation, but is widespread, whilst the marketing of spices is done in many importing centres instead of being confined to a few important markets, as in former times. Probably the total production of spices at the present day is greater than at any former time, though the profits obtained by planters are probably less, since now no

[1] Xanthoudides, however, would derive *kernoi*, libation-tables, tables-of-offerings, and altars from a common prototype, *loc. cit.* p. 15.

single area has a monopoly in the production of any one spice.

One of the most interesting developments in the utilisation of spices in comparatively recent times is in connection with the manufacture of liqueurs, for which large quantities of certain kinds of spices are required. As a rule liqueurs are essentially solutions in alcohol of certain kinds of volatile oils obtained by the distillation of spices. Examples of liqueurs of this kind are "kümmel" and "anisette," which contain respectively caraway and aniseed oils. Apart from this and other methods of using spices for direct or indirect human consumption, considerable quantities of these products are used as flavourings for cattle foods and in veterinary medicine, and familiar examples of this use are fœnugrec and coriander.

By far the largest production of spices takes place in the tropics, since such important materials as ginger, cloves, vanilla, and the peppers can only be grown in such regions, but in addition there are large areas in the temperate and sub-tropical regions devoted to such spices as dill, coriander, cumin, anise, and caraway.

It is proposed in the present article to direct attention to certain of these products which are worth the notice of planters. It must be borne in mind, however, that the cultivation of these materials can never be a great industry, that the supply can easily overtake the demand, and that consequently cultivation should at first be begun on a small scale, and that every effort should be made to produce materials of particularly fine quality, which will readily command a market.

With the exception of fœnugrec, most of these common spices are derived from plants belonging to the natural order Umbelliferæ.

Most of these plants are grown as field crops on a large scale, others are met with in gardens or occur in a semi-wild state. Their cultivation presents no great difficulties, and they are therefore useful as temporary crops or for rotating with crops ordinarily grown in field or garden. Except in the case of fœnugrec, where the seeds proper are employed, the fruit, which is commonly termed the seed

as, for instance, in the case of caraway "seed," constitutes the spice. The fruit of umbelliferous plants is known botanically as a schizocarp, and when ripe it generally splits longitudinally into two partial fruits or mericarps. Each half of the fruit has usually five longitudinal ribs, between which four secondary ribs may be present; furrows (valleculæ) occur between the ridges, and beneath each furrow is usually an oil-duct (vitta) which extends the whole length of the fruit. Contained in the oil-duct is a volatile oil, and it is to this that the fruits owe their aromatic properties and their value as spices. A fatty oil is also present in the seed.

In warm countries spice-yielding umbelliferous plants are usually treated as annuals; that is to say, the sowing and harvesting of the crop takes place in one year; but in temperate climates they are sometimes grown as biennials, the seeds being sown during the summer of one year and the crop harvested during the year following. It is usual to harvest the crop before the fruits are thoroughly ripe, in order to give a bright appearance to the spice, and also to avoid loss of fruits, which occurs on handling plants that are thoroughly ripe and dry. In some cases, however, the semi-ripe fruits have a disagreeable odour, which is lost on attaining ripeness, and in such cases the crop must be allowed to ripen thoroughly before harvesting. The fruits form the best spice when they are dried rapidly without artificially raising the temperature, as exposure to high temperatures is liable to cause a loss of the volatile oil.

The Indian export of the essential oil-seeds now under consideration for the past three years for which figures are available, is shown in the following table:

	1909–10.		1910–11.		1911–12.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	cwt.	£	*cwt.*	£	*cwt.*	£
Aniseed . .	775	758	922	735	1,579	1,354
Coriander . .	68,887	41,049	83,379	72,004	89,688	58,694
Cumin. . .	23,936	38,450	28,090	45,045	25,330	39,983
Dill . . .	10,838	5,046	18,540	8,712	8,486	4,026
Fœnugrec . .	11,362	5,383	146,363	73,710	30,972	17,013

The Straits Settlements, Ceylon, and the United Kingdom, in the order named, are the countries in the British

Empire that take the Indian export in the largest quantities, whilst amongst foreign countries Germany is by far the largest importer.

The value of the exports of some of these products from Morocco in 1909 is shown in the following table:

	£
Coriander	9,481
Cumin	11,836
Fœnugrec	41,354

CARAWAY

Caraways, or caraway "seed" of commerce, is the fruit of a biennial herb known botanically as *Carum carvi*, Linn. It is native to Northern and Central Europe, and is extensively cultivated in Holland, Germany, and Russia, and to a small extent in England. It has been introduced to the United States of America, where it is grown as a garden crop. In Holland the area under caraway has been greatly extended recently, and in 1911 was stated to be 20,570 acres; in 1912, however, the area was less than half that in 1911, as, owing to the dry summer of the preceding year, which was unfavourable to caraway, the greater part had to be ploughed up. The caraway plant has usually a fleshy root resembling that of a parsnip, but smaller, and a slender branched stem that attains a height of from 1½ to 2 ft.; the compound, pinnate leaves are divided into very narrow segments; the small white flowers are borne in flat umbels; the fruit when ripe splits into two narrow, elongated carpels ⅙ in. long, pointed at the ends, and with five longitudinal ridges on the surface.

Soil and Cultivation.—Caraway may be grown in a variety of soils, and succeeds well in a medium clay, but a moderately light soil, that has been well tilled and is rich in humus, gives heavier yields and is probably the most suitable for the crop. In the Netherlands, and even in the extreme northern region of Scandinavia, this crop can be grown without difficulty. The Dutch seed is considered the best, and fetches the highest price on the market. The methods of cultivation in Holland are briefly as follows. The caraway plant, being a biennial, does not produce seed until the second year after sowing, and it is usual, therefore,

to cultivate it as a mixed crop, sowing with it some other crop that can be harvested the first year, care being taken to choose for this purpose a crop that does not grow high enough to unduly shade or choke the caraway plants. The dwarf kinds of pea are commonly employed in Holland as a companion crop, as also are mustard, poppy, field and other beans, flax, and white clover. The caraway and companion crop seeds are sown about March or the beginning of April, either simultaneously or separately. The seeds are usually sown in straight rows from 12 to 16 in. apart, at the rate of 5 to 8½ lb. per acre. After the seed has germinated the soil receives shallow cultivation by hoeing between the rows, and as soon as the companion crop has been harvested, hoeing is renewed and all weeds and foreign growths are destroyed. Towards the end of the first year the soil is drawn towards the plants to protect the crowns during the winter. A dressing of stable manure, or silt taken from ditches and canals, is also applied, and, in the event of the crop being in a weakly condition, a dressing of nitrate of soda is given. As soon as growth commences in the spring of the second year, the ground is hoed and weeded and the surface soil is kept in a loose condition. If well cultivated the plants grow rapidly and commence to flower about the second half of May. The fruits ripen about the end of June or beginning of July.

Harvesting.—This requires to be done with care, as the fruits are easily detached from the plants when ripe, and a part of the crop is liable to get lost if carelessly handled. On this account the plants should be harvested before they are quite ripe. The usual method is to cut the plants with a scythe or sickle or by means of a reaping-machine. The cut stems are tied into loose sheaves, which are placed together in small stacks of from twenty to thirty sheaves and allowed to dry for a week or two, when they are either removed to barns for storage or are threshed in the field.

If this crop has been allowed to become ripe before being cut, the early morning or evening should be chosen for harvesting, as then the dew is on the plants and the

seeds fall less readily than in the hottest part of the day. The crop is secured by placing the stems on a large cloth spread on the ground and beating them with a flail, or by means of an ordinary steam threshing machine.

Yield.—The yield of seeds from rich ground is about 20 cwt. per acre. In Holland it varies considerably, and is frequently from 6 to 16 cwt. per acre; in 1909 the average for the whole country was 9½ cwt. (*i.e.* ten bales: one bale = 110 lb.) per acre. The straw, from 16 to 24 cwt. per acre, is used as fodder or litter for cattle.

Uses.—Caraway is largely used as a kitchen spice and in confectionery, and is also ground up and used in the preparation of curry powders. It is also largely distilled for the volatile oil it yields, which is used in the preparation of liqueurs, such as kümmel, and in confectionery and medicine.

The spice is known on the market by the name of the country of origin, as, for instance, English, Dutch, German, and Mogador seed. The Dutch seed is considered the best for distilling, but Norwegian and East Prussian kinds are also used for this purpose. The yield of oil varies according to the geographical source of the seed. The following figures, quoted from Sawer's *Odorographia*, show the percentages of oil yielded by various kinds of caraway seeds:

German	3·5–5·0	Austro-Hungarian:	
„ (Dutch seed)	4·0–4·3	Styrian	6·0
Bavarian, wild	6·5–7·0	Galician	4·5
East Prussian	5·0–5·5	Moravian	4·0
Wurtemburg, wild	5·5–6·0	Tyrolese, wild	6·5
Hessian	6·0–7·0	Russian	3·2–3·6
Norwegian, wild	5·0–6·5	Finnish	5·0–6·0
Swedish	4·0–6·5	Dutch, East Frisian, wild	5·5–6·0

An inferior oil is said to be sometimes obtained by distilling the husks and stalks that remain after threshing. This is known as "caraway chaff oil," and is used for scenting common soaps.

In Germany the exhausted comminuted seed is dried in a special apparatus and used as fodder for cattle. This fodder has been analysed at the Royal Saxon Agricultural Station, Möckern, and has been found to contain from

20 to 25 per cent. crude protein (75 to 85 per cent. of which is digestible) and 14 to 16 per cent. of fat (Gildemeister and Hoffmann in *The Volatile Oils*). The current price of good Dutch caraway is 33*s.* 6*d.* to 35*s.* per cwt.

Aniseed

Anise or aniseed is the fruit of *Pimpinella Anisum*, Linn., an annual plant indigenous to Asia Minor and Egypt, and cultivated in Spain, Malta, Cyprus, Greece, Southern Russia, and in other parts of Europe where the summer is sufficiently warm to mature the seed. The aniseed plant is a herb, from 2 to 3 ft. high, with cordate radical leaves and biternate, toothed stem leaves. The small yellowish-white flowers are produced in many-rayed umbels that have no involucres. The fruits do not split into two portions as a rule, but are usually seen entire; they are greenish-brown, ovoid, $\frac{1}{8}$ in. long, narrowed towards the top, and surmounted by a pair of short styles; the slender pedicel or stalk is usually persistent. The outer surface is marked by ten longitudinal ridges and is covered by minute hairs. The Russian seeds are smaller than those of other varieties. The European market is supplied principally by Russia, Germany, Scandinavia, Bohemia, Moravia, France, the Netherlands, and Spain.

Soil and Cultivation.—The aniseed plant grows readily from seed drilled in a good loamy soil in rows at such a distance apart as will admit of tilling the soil between, either by horse- or hand-hoes.

Sowing should take place in early spring, as soon as the soil and climatic conditions prove favourable for the operation; the crop then ripens in the autumn of the same year. It is important to keep down, by surface tillage, all weeds and foreign growths after the seed has germinated, as, if left, the weeds become mixed with the aniseed crop at the time of harvest, and the two are threshed together. The presence of weed-seeds in consignments of aniseed lowers the value of the latter considerably. In order to obtain aniseed of bright appearance it is advisable to harvest the crop as soon as the earliest seeds are ripe and before the

whole crop has become fully mature. The crop is cut with a scythe or sickle and is threshed by means of a flail, a sail-cloth being spread on the ground to collect the seed. After being dried the seed should be stored in bags.

Uses.—Aniseed is used, but not to any great extent, directly as a spice; it is valued chiefly on account of the volatile aromatic oil which it yields on distillation. Germany is the largest consumer of aniseed for distilling anise oil, but the industry is said to have declined during recent years, partly owing to the high price of Russian aniseed and to the competition of pure anethole, which can now be prepared from other raw materials. France also employs considerable quantities in the preparation of such liqueurs as Ratafia d'anis, Anisette, etc., and in Spain and Austria it is used in considerable quantities for flavouring purposes.

The following table, quoted in Sawer's *Odorographia*, gives the percentage of essential oil obtained from the principal commercial kinds of aniseed:

Moravian	2·6	Levantine	1·3
Chilian	2·4	Spanish	3·0
Thuringian	2·4	Russian	2·8

A similar volatile oil is obtained from Chinese star anise, the fruit of *Illicium verum*, Hook., a shrub belonging to the N.O. Magnoliaceæ and of no botanical affinity to Pimpinella (see p. 159). In Australia the fruits of an umbelliferous plant known as *Sesili Harveyanum* are said to be used as an aniseed substitute.

In Germany the residue of distilled aniseed is dried and used as cattle food. According to analyses made at the Saxon Experimental Station, Möckern (quoted in *The Volatile Oils*, by Gildemeister and Hoffmann), the aniseed residues contain 17 to 19 per cent. of protein and 16 to 22 per cent. of fat.

The principal supplies of aniseed are obtained from Russia, Spain, and the Levant. There is also a small export from Cyprus (460 cwt. in 1909).

The current price of aniseed on the London market is: Fair Russian 26*s.* 6*d.* per cwt., Fair Spanish 35*s.* per cwt.

Coriander

The plant which yields the coriander seed of commerce is *Coriandrum sativum*, Linn. It is native to Central Europe and the Levant, and is now cultivated in many countries, especially in Moravia, Thuringia, and Russia, whence comes the bulk of the European supply. As a cultivated plant coriander is found all over India, and the spice is exported in considerable quantities, the trade showing an increase during recent years. It is grown in the south of England to a small extent, being sometimes mixed with caraway, the coriander yielding a crop the first year and the caraway during the years following. The coriander plant is an annual herb 1 to 2 ft. high, with a much-branched stem furnished with finely divided leaves. The small flowers, borne in terminal umbels, are of a rose-white colour; the fruit is globular in shape, with the remains of two stigmas projecting from the top; it easily splits into two halves, the inner sides of which are concave. Before it is ripe the fruit has an unpleasant odour. When ripe and dry it is pleasant to the taste and aromatic.

Soil and Cultivation.—In warm countries the sowing takes place during the cold or rainy season; the seed is sown broadcast in sandy loam or black soil. It takes from three to four months to ripen, and the crop requires to be weeded once or twice during that period. In India the seed is sown broadcast after being first rubbed between the hands to separate the halves (mericarps) of the fruits. The sowing takes place at various seasons in the different provinces: in Bengal and the United Provinces the seed is sown during the cold season, in Bombay during the rainy season, and in Madras during the autumn. The seed germinates in about three days, and requires only two weedings. In about a month from sowing the seed has formed, and after it has ripened the plants are pulled and the crop obtained by threshing with a flail, or it is trodden out by bullocks. After being dried in the sun the seeds are stored in bags.

In European countries the seed is sown in September in drills a foot apart, preferably in light, rich soil; about

15 to 20 lb. of seed is required to sow an acre. The young plants are thinned to about 6 or 8 in. apart in the rows. In spring the soil is hoed to keep down weeds. The flowers appear in June and the seed ripens during August. On account of the disagreeable odour of the unripe seed, it must be allowed to remain on the plants until thoroughly ripe. To avoid loss by handling it is advisable to harvest the crop by cutting off the seed-bearing umbels and placing them in bags, rather than to cut down the whole plant. The seed is easily obtained by lightly flailing the plants or umbels in the field—a cloth being spread to receive it.

The average yield from good soil is about 15 cwt. per acre.

Uses.—In Eastern countries coriander enters largely into the composition of curries; it is also valued in medicine, and is used for flavouring spirits. The chief value of coriander in Europe is as a source of an essential oil, which is obtained by steam distillation, and coriander from Moravia, Thuringia, and Russia is chiefly used for distilling. The following figures quoted from Sawer's *Odorographia* give the percentages of oil yielded by various kinds of coriander seeds:

Moravian	0·8	German (Thuringian)	0·6 to 0·8
Dutch	0·6	Italian	0·5
East Indian	0·2	Morocco	0·2 to 0·6
French	0·4	Russian	0·8 to 1

The residue after distillation is used as a cattle food. It contains 11 to 17 per cent. of proteins and 11 to 20 per cent. of fat.

Coriander from the East Africa Protectorate

Two samples of coriander seeds were received for examination at the Imperial Institute from the East Africa Protectorate in November 1911. They were labelled as follows:

"No. 1. Grown in the Kyambu district from seed obtained from India. Harvested about the beginning of October."

"No. 2. Grown in the Kiu district from seed obtained from India. Harvested about the middle of September."

On distillation the samples yielded 0·14 and 0·05 per cent. of oil respectively. The oils were found to have the following constants as compared with commercial coriander oil:

	Sample No. 1.	Sample No. 2.	Commercial oil.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·8781	0·8726	0·870 to 0·885
Optical rotation in 100 mm. tube at 20° C.	+ 11° 47′	+ 9° 5′	+ 8° to + 13°
Solubility in alcohol	Soluble in 1·8 volumes or more of 70 per cent. alcohol.	Soluble in 1·5 volumes or more of 70 per cent. alcohol.	Soluble in 3 volumes or less of 70 per cent. alcohol at 20° C.

The samples were submitted to a commercial expert for valuation, and he reported that they would not be of any value for distillation purposes on account of the low percentage of oil they contained, and that they could only be used as cattle spices, etc. For this purpose sample No. 1 would be worth from 7*s.* to 8*s.* per cwt. and sample No. 2 from 6*s.* to 7*s.* per cwt. (July 1912).

Possibly a better oil-yield would have been obtained had Russian or Thuringian varieties been grown, as they usually contain a larger percentage of oil than Indian kinds.

Cumin

Cumin, or cummin, is the dried fruit of *Cuminum Cyminum*, Linn., an annual plant native to Egypt and the Mediterranean region, and found in cultivation in Arabia, India, and China. The plant is said to ripen its seeds as far north as Norway, but Morocco, Malta, and Sicily furnish the chief supplies.

The cumin plant is a slender annual, 1 to 2 ft. high, with twice or thrice tri-partite leaves deeply cut into filiform segments; the fruits resemble those of the caraway plant, but are larger and lighter in colour and have nine ridges on each half (mericarp).

"Black cumin," which is extensively cultivated in India, is the seed of *Nigella sativa*, a ranunculaceous plant native to Southern Europe, and quite distinct from true cumin.

Uses.—Cumin seed was formerly used as a common

flavouring spice in England, and is so employed in Germany at the present time, but elsewhere in Europe it has been largely replaced by caraway. In Holland it is said to be used for flavouring cheese. It is largely used as a spice and curry ingredient in India, where considerable importance is also attached by natives to its medicinal properties. In Europe the medicinal use of cumin is confined to veterinary practice. The seeds are powerfully aromatic, but are hotter and far less agreeable to the taste than caraway. They yield a volatile oil, known as "oil of cumin," which is employed in European countries in the manufacture of liqueurs. The following table, quoted from Gildemeister and Hoffmann's *Volatile Oils*, gives the percentage of oil obtained from the principal commercial kinds of cumin seed used for distilling:

East Indian	3·0–3·5	Morocco	3·0
Maltese	3·5	Syrian	2·5–4·0

Germany is by far the largest consumer of cumin; France and Spain rank next, in the order named. A considerable quantity of cumin seed is exported from India, the United Provinces and the Punjab being the chief producing provinces. The modern traffic is almost exclusively from Bombay and Bengal, the exports being consigned for the most part to Ceylon, the Straits Settlements, and British East Africa. India also imports considerable quantities of cumin seed across the North-Western land frontier and from the Red Sea and Persian Gulf ports. The chief trade centres are Jubbalpur, Gujarat, Rutlam, and Muscat.

The Indian exports for the past three years are shown in the table on p. 123.

In Malta the area under cumin in 1911–12 was returned at 1,594 acres, and the produce (13,256 cwt.) was exported chiefly to France (5,075 cwt.), Italy (4,100 cwt.), Germany (1,512 cwt.), Holland (668 cwt.), and the United Kingdom (645 cwt.). The value of the total export was £14,374.

The exports of cumin seed from Morocco for the year 1909 were valued at 295,897 francs (£12,329).

The current price of cumin in London is as follows: Good Morocco, 25*s.*; Fair Malta, 22*s.* per cwt.

Dill

Dill is a glabrous herb indigenous to Central and Southern Europe, but found abundantly in other countries, its range extending from Spain to the Caucasus and Persia, and southwards into Egypt and Abyssinia. It is also found throughout tropical and sub-tropical India, and is cultivated to a small extent in England. The plant is known botanically as *Peucedanum graveolens*, Benth. (syn. *Anethum graveolens*, Linn.), and is distinguished by the absence of an involucre to the inflorescence. It grows to a height of from 2 to 2½ ft., and has glaucous-green, hollow, branching stems, furnished with finely-cut bi- or tri-pinnate leaves. The compound umbels of small yellowish flowers are followed by fruits that are flattened from back to front, and have a membranous border or wing; the ridges are six in number, three of which occur on each half (mericarp) of the fruit.

In European countries the seed is usually sown in autumn in warm positions in light, well drained soil, either broadcast or in drills 6 to 12 in. apart. The young plants are thinned in spring to about 10 in. apart, and the soil is hoed and kept free from weeds. Harvesting is effected as soon as the seeds are mature, in the manner already described for similar plants of this family. In India it is cultivated as a cold weather crop, and is sometimes met with as a weed of cultivation. The form grown in India differs slightly from the European plant in having a fruit a little longer and more narrowly winged. By some botanists this is considered a distinct species, and it has been named *Peucedanum Sowa*, Kurz (syn. *Anethum Sowa*, Roxb.). The essential oil obtained from this plant also differs from that derived from the European species.

Uses.—In India the leaves are cooked as a pot-herb along with other vegetables. In Europe the seed is distilled for the volatile oil it contains. The following table, quoted from Sawer's *Odorographia*, gives the percentages of oil obtained from the principal commercial kinds of dill seed:

German	3·8	East Indian	2·0
Russian	4·0	Roumanian	3·5

The seeds are also employed as a condiment, specially for pickling with gherkins, and in the north of France they are often used for flavouring winter preserves. Dill oil is used to a considerable extent in medicine as a carminative. According to Gildemeister and Hoffmann (*loc. cit.*), the dried distillation residues contain 14·5 to 15·6 per cent. of protein, and 15·5 to 18 per cent. of fat, and are used as a cattle food.

Dill from the East Africa Protectorate

Two samples of dill seed were received for examination by the Imperial Institute from the East Africa Protectorate in January and July 1910 respectively. The second sample was stated to have been grown at Limoru at an altitude of 7,000 ft. On distillation the samples yielded 2·8 and 2·06 per cent. of oil respectively. An examination of the oils gave the following results compared with oil from European dill:

	Oil from East African seed.		Oil from European seed.
	Sample No. 1.	Sample No. 1.	
Specific gravity at 15° C.	0·9174	0·9117	0·895 to 0·915
Optical rotation in 100 mm. tube at 20° C.	+ 77° 10′	+ 77° 3′	+ 75° to + 80°
Solubility in alcohol .	Soluble in 1·6 or more volumes of 80 per cent. alcohol.	Gave a clear solution with 6 to 6½ volumes of 80 per cent. alcohol.	Soluble in 5 to 8 volumes of 80 per cent. alcohol.

Commercial experts to whom the samples were submitted for valuation reported that sample No. 1 would probably be worth 18*s.* to 22*s.* per cwt. on the London market (March 1910), and sample No. 2 was valued by one firm at about 34*s.* per cwt. or less, and by another at 27*s.* per cwt. (December 1910).

Fœnugrec

Fœnugrec or fenugreek of commerce consists of the seeds of a robust, annual, leguminous herb, known botanically as *Trigonella Fœnum-græcum*, Linn. It is native to Eastern Europe and Abyssinia and is cultivated throughout the Mediterranean region and also in Egypt and India. The plant has smooth, erect stems, more or less branched,

that attain a height of from 8 to 12 in. or more; the leaves are trifoliate, the leaflets smooth, oblanceolate-oblong, coarsely toothed, and about 1 in. in length; the flowers, produced singly or in pairs in the axils of the leaves, are sessile, small, and of a yellowish colour; the pod is from 1½ to 3 in. in length, linear, more or less curved and pointed; the small seeds are of a rhomboidal shape and brownish-yellow in colour; from 10 to 20 seeds are contained in each pod.

Cultivation.—In India fœnugrec is grown near wells and on lands subject to inundation (*sailáb* lands), a rich alluvium or clayey loam being generally selected. On well lands it is sown in February at the rate of 30 lb. of seed per acre, and the crop is ready to cut in April. On *sailáb* lands it is sown at the end of October or the beginning of November, and the crop ripens about the same time as that grown on well lands.

In Egypt fœnugrec is grown both for fodder and for seed, but the area in Lower Egypt under this crop is small. In Upper Egypt it is usually grown as a mixed crop with vetches, berseem, beans, and barley. When grown with vetches it is invariably eaten off as a green fodder. The seed is sown when the Nile water passes off the land at the end of October or beginning of November, at the rate of four kelahs of seed per feddan (= about 1½ pecks per acre).

In the Delta it is sown in water after ploughing, up to November 20. One or two subsequent waterings are given in the Delta, but in Upper Egypt it is grown without water. When grown with cereals the two crops are harvested and thrashed together, the seed of the fœnugrec being separated later. Under these conditions the yield is about 2 ardebs per feddan (about 10 bushels per acre). When grown pure the yield is from 2 to 4 ardebs per feddan (from 10 to 20 bushels per acre).

In the Mediterranean region it is sown in spring at the rate of from 13 to 16 lb. of seed per acre, preferably after rain. The pods ripen in succession from the base of the plant upwards, and as they dehisce and scatter the seeds it is necessary to harvest the plants as soon as the first-formed

pods are ripe, and whilst many of the later-formed pods are still green.

Uses.—The plant is grown as a fodder-crop for cattle, after the manner of lucerne, but chiefly for the sake of its seeds, which have aromatic and stimulant properties. The seeds are used in veterinary medicine and form one of the ingredients of concentrated cattle foods. In the East they are used in curries and are germinated and the sprouts eaten as a vegetable. In the United States of America fœnugrec has been tried as a green manure and has been found especially suitable for coastal regions.

The current price of "Fair Morocco fœnugrec" is 9*s.* per cwt.

MANUFACTURE OF PAPER PULP FOR EXPORT

UNTIL about the middle of the nineteenth century, paper was manufactured almost exclusively from rags of various textile fabrics. This material is still employed to a considerable extent in the manufacture of better class papers; it yields a paper pulp of excellent quality with no very drastic treatment. Owing, however, to the tremendous development of the paper trade and a deficiency in the supply of rags, it became necessary to find substitutes to supplement this material. Wood, straw, and esparto were among the chief materials put forward in response to this demand, and various methods were devised for the preparation of a suitable paper pulp from them. Numerous other fibrous materials have been exploited from time to time, but only a few of them have acquired any permanent commercial importance.

The conversion of a fibrous material into a pulp suitable for the manufacture of paper consists essentially in the separation of the "ultimate" fibres of the material from their incrusting substances. As a general rule, the more thoroughly this separation is effected the better the quality of pulp produced; but it is essential that the ultimate fibres should not be broken or weakened to any great extent during the process.

Wood Pulp.—Wood pulp is by far the most important paper-making material at the present day, on account of its cheapness, and as a result of the applicability of its various qualities to the manufacture of different classes of paper. The coniferous trees yield soft wood most suitable for pulp, but other varieties of wood are being increasingly employed for the purpose. Recently, extensive investigations as to the treatment necessary for, and the yield of pulp from, various woods have been made by the U.S. Dept. of Agriculture (*Paper Pulps from various Forest Woods*, U.S. Dept. Agric., March 1912).

The pulping process may be either chemical or mechanical, the latter being cheaper, but yielding an inferior product.

In the preparation of mechanical pulp the timber is first sawn into two-foot lengths and the bark removed. The grinding is effected by means of grindstones revolving at a rapid rate, either vertically or horizontally, against the surface of which the logs are forced by hydraulic pressure. The stones are enclosed in casings provided with trap-doors through which the wood is introduced. A stream of water, constantly running through the machine, carries the pulp away to strainers, where it is freed from knots and pieces of wood insufficiently ground. The finely divided pulp passing through is run to a machine, where it is converted into sheets suitable for export.

In the earlier processes for the manufacture of ground wood, the wood was applied to the stone in such a manner that the surface of the stone ground across, not along, the grain of the wood; the resultant product was practically a powder, possessing little felting power, and of little use for the manufacture of paper. In the more modern processes, however, the wood is pressed against the revolving stone so that the fibro-vascular bundles are torn away entire, not cut transversely.

Mechanical wood pulp loses its felting power to a considerable extent if it is stored dry for any length of time. It is for this reason that most of the mechanical pulp imported into this country is imported in a moist condition.

The chemical pulping of wood is essentially a process of digestion of the chipped wood with a disintegrating chemical solution under pressure at a high temperature.

In the "sulphite" processes the liquor employed consists of an aqueous solution of "bisulphite" of lime or magnesia. It is usually prepared by passing sulphurous acid gas (produced by burning sulphur or pyrites) up towers packed with lumps of limestone or dolomite through which water is trickling. The digesters commonly employed are of steel, lined with lead or acid-resisting brick, or with a combination of these two materials. The actual digestion may be carried out by one of two methods, the "quick" or the "slow" (Mitscherlich) process. In the former the pressure employed is 65 to 85 lb. per square in. and the digestion seldom occupies more than 16 hours; in the latter the pressure never exceeds 45 lb. per square in. and the time occupied is 36 to 48 hours. The sulphite process is the most important of the chemical processes.

In the soda process, the liquor used for digesting the wood consists of an aqueous solution of caustic soda. The concentration of the soda solution and the pressure employed are naturally greater than those required for the pulping of such materials as esparto and straw. The pulp produced is of good quality and is especially suitable for the manufacture of certain classes of paper. Owing to the cost of the caustic soda, this has to be recovered by evaporation of the liquors and recausticising the residue with lime.

A chemical process which is finding increasing popularity is the "sulphate" process. The initial liquor used consists of a solution of a mixture of sodium sulphate and sodium hydroxide (caustic soda), the loss of chemicals being made up by the addition of more sodium sulphate.

Chemical wood pulp is of much better quality than that produced mechanically, and fetches a considerably higher price. Most of the chemical pulp is imported into this country in the dry state, as the loss of felting power which takes place with mechanical pulp does not occur with this product.

Esparto.—Esparto is another paper-making material of

importance. It is usually exported from its country of origin in compressed bales, comparatively little being exported as pulp. It is a grass, or more correctly a sedge, which grows wild over large tracts in Spain and Northern Africa. It was introduced into this country as a paper-making material in the middle of the last century by Thomas Routledge, and rapidly attained great popularity; in 1862 it was the chief ingredient of most English newspapers. The pulping of esparto is carried out with caustic soda solution in digesters provided with a "vomiting" device, which prevents the grass collecting in masses and being, in consequence, unevenly digested. As will be seen from the following table, the import trade in esparto grass does not show the same rapid progress as that in the better-class wood pulps.

Imports of Esparto Grass and Wood Pulp to the United Kingdom

Year.	Esparto grass and other vegetable fibres.	Wood pulp (total).	Year.	Esparto grass and other vegetable fibres.	Wood pulp (total).
	Tons.	*Tons.*		*Tons.*	*Tons.*
1902	198,292	525,799	1907	202,523	672,499
1903	179,089	576,153	1908	192,975	748,434
1904	200,245	569,245	1909	197,501	749,739
1905	191,114	578,012	1910	193,218	859,983
1906	188,192	606,811	1911	201,636	784,296

Straw.—Large quantities of straw pulp are imported into this country for the manufacture of brown papers and straw boards. The straw, chopped into pieces of about 2 in. in length, is heated with caustic soda in horizontal rotating digesters. The yield of pulp from the straws of wheat, barley, oats, and rye, which are most commonly employed, varies from 40 to 45 per cent.

Bamboo.—Bamboo is now coming into commercial prominence as a source of paper pulp. The Chinese have long employed it for the manufacture of their native paper, but though it had attracted the attention of investigators from time to time, the drastic treatment necessary to disintegrate the nodes of the mature canes had prevented its commercial success. Routledge, the pioneer of the esparto industry, suggested in 1875 the use of young canes, which when treated with hot, dilute alkaline lye and subsequently

washed and dried, would yield a fibrous, tow-like mass which could be compressed into bales and exported in this form. Investigations on the utilisation of bamboo have recently been carried out by Sindall (*Manufacture of Paper Pulp in Burma*, 1906, and *Bamboo for Paper Making*, Marchant Singer & Co., 1909), and Raitt (*Indian Forest Records*, 1912, **3**, Pt. iii, 1). Sindall recommends the removal of the nodes from the canes before digestion; an evenly digested pulp is thus assured. Raitt has shown that a previous crushing and treatment of the canes with hot water avoids the necessity of removing the nodes, and also effects a saving in the time of digestion and the consumption of chemicals. The estimated cost of production of a ton of unbleached pulp is about £6, so that in the Far East bamboo pulp can compete with wood pulp imported from America.

Many other materials besides those already mentioned yield excellent paper pulps. In America the "fuzz" remaining on cotton seeds after the removal of the lint is used to a considerable extent and yields paper of excellent quality. "Bagasse," or "megasse," the fibrous residue obtained after the removal of the juice from the sugar-cane, yields a paper pulp which appears likely to become an article of commercial importance (see this BULLETIN, 1910, **8**, 151). A process has recently been devised whereby a higher yield of sugar is obtained from the cane and the fibres are left in a more suitable condition for pulp manufacture (*Paper Maker's Monthly Journal*, 1913, **51**, 8).

Numerous other materials which yield paper pulp are described in *Selected Reports of the Imperial Institute, Part I., Fibres*, and this BULLETIN (1912, **10**, 372, this Vol., pp. 68, 163).

It does not follow that because a fibrous material yields a good paper pulp it can be employed for this purpose on a commercial scale. If it is to be converted into pulp in the country of origin, there is the question of available power and supply of chemicals for the pulping processes; if it is to be exported in its raw condition, the cost of transport often proves a serious obstacle, owing to the bulky nature of many of these materials. In any case the cost of production must be kept down to such a level that it

can compete with wood pulp and esparto in the market in which it is placed. The price of unbleached chemical wood pulp in London is £7 10*s.* to £8 12*s.* 6*d.* per ton for pulp prepared by the soda process, and £8 5*s.* to £8 10*s.* per ton for that prepared by the sulphite process (February 1913); the price of North African esparto grass in London ranges from £3 2*s.* 6*d.* to £3 12*s.* 6*d.* per ton, and that of Spanish esparto grass from £4 10*s.* to £5 2*s.* 6*d.* per ton. Further, it is absolutely necessary, if a raw material is to attain any commercial importance as a source of paper, that a large and constant supply should be forthcoming.

GENERAL NOTES

Sisal Hemp Cultivation in German East Africa.—Although the cultivation of Sisal hemp in German East Africa has not yet been in progress for quite twenty years, the industry has already attained an important position. Some interesting information on this subject has been furnished by Dr. W. F. Bruck, who has recently made a tour of the country (*Verhandlungen des Vorstandes des Kolonial-Wirtschaftlichen Komitees*, 1912, No. 2, 39).

In 1911, 11,212 metric tons of Sisal hemp were exported, of the value of about £226,000, and it is estimated that the exports in 1912 amounted to at least 16,500 tons, and that ere long the annual exports will reach 20,000 tons. The cultivation is not limited to particular districts of the Protectorate, but can be carried on under widely different conditions of soil and climate.

The plantations are usually made by means of suckers of various sizes up to 18 in. On soils which are not too rich in nutritive constituents or humus, the leaves can usually be cut for the first time after three years, and can be gathered subsequently for from five to seven years. If the soil is particularly rich, as in the Usambara District, the plants are ready for cutting after about eighteen months, but afterwards only live for about three years. On poor soils, on the other hand, the agaves do not yield mature leaves until four or five years from the time of planting, but the life of the plant is usually longer than in other cases. In general, however, whatever be the nature of the soil, the plant yields during its life about 200 leaves for fibre extraction, and the leaves furnish about 3½ to 4 per cent. of their weight of fibre.

In order that a Sisal hemp estate may be developed

in the most profitable manner, an extensive area of land is necessary. It must be borne in mind that an extracting machine, such as the "New Corona," requires 100,000 to 120,000 leaves per day, so that in a year of 300 working days, 30,000,000 leaves should be available. Moreover, it is of importance that land should be available for the creation of new plantations, and that the plans for these should be worked out in a systematic manner, so that there is always a sufficient number of leaves ready for cutting throughout the year.

There are two systems of cultivation in vogue. In one system (the "rational" system) the suckers are regularly removed from the parent plant, whilst in the other they are allowed to remain in the ground and develop naturally. The latter method has the advantage that there are always leaves ready for cutting, and the need of providing new plantations from time to time is thus obviated. It presents the disadvantage, however, that the plantations cannot be cleaned without great difficulty, and that the leaf material, and consequently the fibre, is irregular. Moreover, such plantations suffer much more from the attack of fungi, bacteria, and other pests than do those which are cultivated in the "rational" manner. The weeds and undergrowth grow very thickly, and afford a breeding-place for all kinds of pests. There is the further danger that, in such circumstances, an epidemic might break out or that a degeneration of the plants might take place.

There is no doubt that the "rational" system, in which the plants are properly spaced and the plantations regularly weeded, gives as a rule better results, and particularly in yielding fibre of more regular quality. When no secondary crop is grown between the agaves, the best distances for planting are, on the average, 7 ft. 6 in. by 4 ft., but of course will vary to some extent with the nature of the soil. In districts which are well adapted for cotton, the planting of this crop between the Sisal hemp plants has given good results, but it cannot be recommended for lands which do not possess well marked dry and wet seasons. In general, such secondary crops are more or less detrimental, and are not advisable unless they are of such a nature as to improve the soil. In the case of soils which have become exhausted by the prolonged cultivation of Sisal agaves, it is suggested that leguminous plants should be grown, or that the land should be left fallow for some time.

Recent Developments in Cotton Growing in the United States.— The principal conclusions which have been drawn from recent work on the cotton crop by the United States Department of Agriculture have been summarised in *Circular* No. 96, *Bureau of Plant Industry.*

Improved varieties of American Upland cotton have been produced, and the seed distributed to planters. The Columbia variety, an early-ripening kind with a long, strong, and regular fibre, originated in South Carolina; it has proved to be well suited to extensive areas in the eastern part of the cotton belt, and has given good results in Western Tennessee. The Foster variety, a hybrid between long-stapled Upland and Texas Big Boll, has afforded excellent results in some localities, but appears liable to variation. Other varieties which have proved satisfactory are Lone Star, developed from the Texas Big Boll type, and Trice, a particularly early-ripening, short-stapled form obtained by selection from a local stock, known as Tennessee Green Seed.

Cotton growing is being introduced into the drier parts of Texas and other south-western States; extension in this direction is very desirable, as the boll-weevil effects less damage in a dry climate. Several types of cotton have been introduced from boll-weevil infested regions of Mexico and Central America, and four of these—viz. Kekchi, Durango, Acala, and Tuxtla—have proved very successful; in addition to possessing certain characters which afford some degree of protection against the boll-weevil, they give an abundant yield of cotton of good quality and 1 to 1¼ in. long. The Durango variety is very promising for irrigated districts in Texas and other south-western States; the plant is more resistant to drought than most other long-stapled cottons, and it bears large bolls, which ripen early.

Efforts have been made to induce planters in particular districts to co-operate with the object of producing a single superior variety of cotton. The adoption of this practice would obviate the hybridisation of varieties in adjacent fields, and the mixing of seed in the ginneries would facilitate selection, and would enable a large quantity of cotton to be produced of a uniform character, and consequently of higher value. The necessity for continued selection, in order to maintain the quality of superior varieties, has been confirmed, and improved methods of selection have been devised.

It often happens that young seedlings exhibit malformation of the leaves, and in many cases also lose their terminal bud. Development is thereby retarded, and the yield of cotton is reduced. Advice is given with regard to the cultural methods to be adopted in order to avoid such injuries.

Experiments are being continued on the crosses between Egyptian and American Upland varieties, and also on the propagation of such hybrids by means of cuttings.

Egyptian cotton plants show less tendency to shed their buds and young bolls than those of the American Upland

varieties. Another advantage of Egyptian cotton is that the crop is more easily picked than that of Upland cotton, and it is therefore superior as a family crop, *i.e.* a crop worked entirely by the planter and his family. Although Egyptian cotton has been grown successfully in Arizona and Southern California, it cannot be expected to give similar results on irrigated lands in Texas, where quite different conditions prevail; for the latter region, the Durango variety is to be preferred.

Cocoa from Southern Nigeria.—Next to the products of the oil palm cocoa is the most important agricultural product exported from Southern Nigeria, the quantity exported in 1911 being 88,025 cwt., valued at £164,664. In order to demonstrate to the natives the advantage of properly preparing their cocoa, the Agricultural Department recently undertook the preparation of a certain quantity of native-grown cocoa for the market. A sample of the cocoa so prepared was submitted for valuation to a firm of merchants in Liverpool. They reported that it compared favourably with Gold Coast cocoa, and valued the sample at 55*s.* to 56*s.* per cwt., with ordinary Ibadan cocoa at 50*s.* to 51*s.* per cwt., and fine fermented Accra cocoa at 55*s.* per cwt. (December 1912). The firm in question are prepared to buy cocoa of similar quality in Southern Nigeria at prices higher than those paid for ordinary native cocoa.

The Agricultural Possibilities of the Panama Canal Zone.—The maintenance in the Panama Canal Zone of a large body of men dependent almost entirely upon outside sources for food, together with the increasing geographical and economic importance of this strip of land, led to an agricultural survey by the United States Department of Agriculture in 1909, and the results of the survey form *Report No.* 95 (1912) *of the Office of the Secretary* of that Department. The Canal Zone extends the whole length of the canal and five miles either side of its median line, and has an area of 450 square miles, of which about 325 square miles will be available for cultivation. The agricultural methods at present practised in this area are very primitive, and the production of the local staple products, principally tropical vegetables and fruit, rice and maize, is little more than sufficient for the needs of the holders themselves.

Owing to the broken topography of the country, large farming operations are impracticable; the best method of development appears to be by a series of small farms, operated by the proprietors themselves or under the management of a central authority. The scheme which promises most success is the development of a permanent mixed tropical agriculture. Among the fruits and

vegetables suggested for cultivation are mangoes, avocados, pineapples, and mangosteens, all of which seem well adapted to the local conditions. Staple crops, as maize, cassava, yams, sugar-cane, plantains, bananas, and mountain rice, are already well established. Cocoa, coffee, and rubber are other suggested crops.

Afforestation is proposed for areas not suitable for agriculture. Teak and various species of Eucalyptus are recommended in this connection.

Mineral Output of New South Wales.—The *Annual Report of the Department of Mines, New South Wales*, for 1911, records a total mineral output valued at £9,758,006, an increase of £1,021,537 on that for 1910.

The gold output was valued at £769,353, a decrease of £32,858 on that for 1910, and is the lowest recorded since 1902. The tin produced showed a substantial increase, being valued at £307,089, an increase of £78,933 as compared with 1910. The yield of gold and tin obtained by dredges forms an important item. During the past twelve years the dredges have won 329,704 oz. of gold, valued at £1,400,498, and 10,566 tons of stream tin, valued at £1,049,255. The dredges in operation numbered 71, of which 35 were employed in the recovery of gold, and 36 in winning stream tin.

The coal output increased, and amounted to 8,691,604 tons, valued at £3,167,165, an increase of £157,509; so also did the output of kerosene shale, which amounted to 75,104 tons, valued at £36,980, being an increase of 6,811 tons and £3,084 in value on the figures for 1910.

Among the silver, lead, and zinc mines, notable events were the resumption of work underground at the Proprietary Mine, and the location of a large ore-body at the Thomson section of the British mine. The total value of the silver and silver-lead ore produced was £2,442,764, an increase of £581,285 on the previous year.

The output of copper was valued at £590,102, an increase of £61,520, due to the improved returns from the Great Cobar district which took place in spite of the scarcity of skilled labour.

Diamonds amounting to 5,771 carats, valued at £4,064, were won, the entire yield being obtained from the deposits at and near Copeton. This is an increase of 2,165 carats and £1,183 in value over that in 1910. Opal mining resulted in some rich finds, one stone, weighing 5 oz., being valued at £300. The total opal output was valued at £57,300, a decrease of £8,900, due to a reduction in price of the stone, which caused a number of miners to leave the field and seek employment elsewhere.

Other minerals which show increased production are limestone, alunite, shale, wolframite, platinum, and anti-

mony ore. There were decreases in the output of iron ore, scheelite, molybdenite, and various other minerals of minor importance.

Mineral Output of Queensland.—According to the *Annual Report of the Under-Secretary for Mines, Queensland*, for 1911, the value of the year's output of minerals was £3,661,063, a decrease of £49,159 as compared with 1910.

The value of the gold extracted was £1,640,323, a decrease of £234,627. A notable feature of the year was the disclosure in the Brilliant Deeps Mine at Charters Towers of a strong and rich reef at a depth of 2,500 ft., affording encouraging evidence as to the prospects of deeper working in that field.

The total value of the silver-lead output was £79,765, a decrease of £43,321.

The output of copper was 20,384 tons, valued at £1,151,351, an increase in value of £218,862, making some amends for the decrease in gold and silver-lead.

The uniformly high price of tin during the year proved an incentive to tin-mining, and the output of the metal was 3,091 tons, valued at £307,847, compared with 2,953 tons, valued at £243,271, in 1910. Considerable development took place in the Herberton District, and promising discoveries of ore were made.

In the production of wolframite, molybdenite, and bismuth there was little change; but wolframite declined slightly towards the end of the year, in spite of the satisfactory value of tungsten ores.

The normal output of 1,000 tons of manganese ore at Mount Miller, in the Gladstone District, was maintained, the whole of this being taken by the Mount Morgan Chlorination Works. The Mount Morgan Company's quarry at Marmor produced 92,407 tons of limestone, valued at £17,916.

The gem industry of the Anakie sapphire field was maintained, although no new deposits were found. The population of the field was 511, and the year's output of stones was valued at £24,393. The conditions on the opal fields continued unchanged, the estimated value of the output being £3,000.

The gradual expansion of the coal-mining industry continued. New mines were opened and new machinery introduced. During the year, forty-two collieries produced 891,568 tons, valued at £323,998, being, when compared with the previous year, an increase in the number of collieries of five, in output of 20,402 tons, and in value of £1,176, but a decrease in average value of twopence per ton.

During the year, direct State assistance amounting to £18,000 was given for various purposes in connection with the mining industry.

The Utilisation of Zirconium Minerals.—The zirconium mineral of most frequent occurrence is the silicate known as zircon (ZrO_2,SiO_2), which, when pure, contains 67·2 per cent. of zirconia and 32·8 per cent. of silica. Zircon was formerly the source of commercial zirconia, but it now appears to have been largely displaced by the mineral baddeleyite (zirconia, ZrO_2), which requires comparatively little preparation before use.

Baddeleyite occurs in large quantities in certain gravels of the Serra de Caldas in Minas Geraes, Brazil, and is stated to occur in three forms, the composition of which is shown in the following table:

	Glassy fragments.	Stony fragments.	Pebbles.
	Per cent.	*Per cent.*	*Per cent.*
Zirconia ZrO_2	94·12	88·40	74·48
Titanium dioxide TiO_2	0·98	3·12	1·35
Ferric oxide Fe_2O_3	3·22	4·07	10·26
Silica (free) SiO_2	0·43	2·50	14·08
Silica (combined) SiO_2	1·98	3·39	

The glassy variety can be freed from most of its ferric oxide by mechanical means, yielding a product which contains about 98 per cent. of zirconia. Various grades of prepared powdered zirconia are now offered for sale at the following rates:

Percentage composition.	Price per metric ton.
Zirconia, 90 to 92; ferric oxide, 1·0; silica, 8·0	£35
„ 90 to 92; „ „ 7·0; „ 1·0	£36
„ 98·00; „ „ 0·8; „ 1·0	£50

Probably the largest field for the utilisation of zirconia is its employment as a refractory material for crucibles and furnace hearths. Various methods of preparing these have been described. In one of these methods a mixture consisting of 90 parts of zirconia with 10 parts of magnesia is used, and made into a paste with 10 per cent. of phosphoric acid. Crucibles moulded from this mixture are said to be very resistant, and practically unaffected by molten alkali or strong acids. In another method starch serves as the binding agent, and the crucibles, after being dried at a low temperature for several days, are fired in a Hempel electric furnace at a temperature of 2,000 to 2,300 °C. Zirconia crucibles are now being manufactured in Germany.

Owing to its very low coefficient of expansion, ware made from zirconia can be plunged red-hot into water without risk of fracture. The suggestion has been made

that zirconia could be used in ceramics, but for this purpose cheap zirconia free from iron would be required. Zirconia ware is said to be suitable for use as an electrical insulator up to temperatures of about 2,000° C.

It is stated that small quantities of zirconia are being used in the manufacture of a variety of silica ware known as "siloxide." The best results as regards resistance to devitrification were obtained by using about 0·5 per cent. of zirconia; but the best tensile strength was given when using about 1 per cent. of zirconia.

The use of clean zirconia as a pigment has been patented; it is stated to possess a pure white colour, and good covering power, and to be durable and non-poisonous. The silicate, basic carbonate, phosphate, and basic sulphite of zirconium have also been suggested as suitable for use as pigments.

Some years ago zirconia found a use as a component of the "glower" in the Nernst lamp, and was also tried, as a substitute for thoria, in incandescent gas mantles.

Zirconia is stated to be used, under the name "kontrastin," in place of bismuth salts for defining X-ray photographs of the intestines. Basic zirconium acetate has been patented as a weighting material for silk.

Ferro-zirconium, containing about 20 per cent. of zirconium, is made in the electric furnace, and employed to a small extent in the refining of steel, the quantity used being about 1 per cent. of the steel treated. Zirconium carbide was at one time used for incandescent electric-lamp filaments, but has been displaced by metallic filaments. It is also stated to be an excellent abrasive and to be suitable for cutting glass.

At the present time the demand for zirconia is met almost entirely by Brazilian baddeleyite, of which there is an ample supply. This mineral, as well as zircon, has also been found in Ceylon by the officers of the Mineral Survey working in that country in connection with the Imperial Institute (see *Colonial Reports, Miscellaneous Series*, No. 29 [Cd. 2341], 1905, p. 23; No. 37 [Cd. 3190], 1906, p. 21; No. 42 [Cd. 3762], 1907, p. 15; No. 74 [Cd. 5390], 1910, p. 6).

Ash of Cyperus Haspan.—An account of the ash of *Cyperus Haspan*, L., a reed grass found on the banks of certain rivers in the Ssongea district in German East Africa, is given in *Der Pflanzer* (1912, **8**, 678). The ash is noteworthy on account of the large percentage of potash it contains. "Salt" is prepared on a small scale for local use by the natives by treating the ash with water in a basket. The liquid which passes through is boiled down and the salt recovered. An analysis of this product gave the following percentage results, which are somewhat similar to those obtained at the Imperial Institute for a sample of "Kegr"

salt from Northern Nigeria, prepared from the ash of *Salvadora persica* (see this BULLETIN, 1912, **10**, 304):

Potassium chloride . .	KCl	77·77	Silica	SiO_2	0·25
Potassium sulphate .	K_2SO_4	18·48	Water	H_2O	2·39
Ferric oxide and alumina	Fe_2O_3, Al_2O_3	0·23	Insoluble matter		0·35

Only traces of calcium, magnesium, and sodium salts were present; carbonates of the alkali metals were absent.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.

AGRICULTURE

SOILS

ANALYSES of 152 soils from Nag Hamadi, Egypt, are given in *Bull. de l'Inst. Égypt.* (1912, Ser. 5, **6**, 136) These soils, which were examined by the method described in the same journal with a view to ascertain their requirements for sugar-cane cultivation, were of three general types. These were, sandy soils from Safra, loams from Motawaseta, and clay soils from Zarga. The soils did not differ greatly in chemical composition, as is indicated in the following table:

	Soluble in concentrated nitric acid.		Soluble in $\frac{1}{100}$ hydrochloric acid.	
	Top soil.	Subsoil.	Top soil.	Subsoil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Potash. Safra	0·201	0·148	0·056	0·035
,, Motawaseta . . .	0·179	0·144	0·058	0·038
,, Zarga	0·209	0·178	0·058	0·038
Phosphoric acid. Safra . . .	0·171	0·150	0·065	0·054
,, ,, Motawaseta .	0·153	0·147	0·056	0·050
,, ,, Zarga . . .	0·160	0·156	0·058	0·051
Lime. Safra	2·00	2·00	—	—
,, Motawaseta . . .	2·22	2·10	—	—
,, Zarga	1·95	2·01	—	—
Nitrogen. Safra	0·052	0·035	—	—
,, Motawaseta . . .	0·048	0·037	—	—
,, Zarga	0·048	0·041	—	—

The composition of the subsoil in all cases shows that a good reserve of plant food is present. Certain soils, typical

of the areas, were examined for alkali salts; those of Safra and Motawaseta contained on the average 0·08 and 0·07 per cent. respectively of sodium carbonate, together with 0·17 and 0·18 per cent. of sodium bicarbonate. The Zarga soils contained 0·19 per cent. of bicarbonate, but no carbonate. The application of dressings of calcium sulphate is recommended in order to neutralise the effects of these salts. The great influence of the physical condition of the soil on the crop is here illustrated by the fact that although these three types of soil are almost identical in plant food resources, the Safra lands yield two to five sacks of sugar per acre more than those of Motawaseta, which in turn have a similar advantage over the Zarga soils. The most important manure required by these soils is nitrogen, which is very essential for the growth of sugar-cane, and this is applied in the form of ammonium sulphate.

Comparative chemical and mechanical analyses of soils from German East Africa and South America are given in *Der Tropenpflanzer* (1912, **16**, 571). From the results obtained the author concludes that the soils of Tanga, Longusa, Ngambo, and Magunga, on certain of which Ceara rubber (*Manihot Glaziovii*) is being grown, are very similar to Bolivian soils from Acre, on which wild Para rubber (*Hevea brasiliensis*) is growing. The author concludes that, under proper climatic conditions, a soil suitable for rubber need not contain a high percentage of nitrogen, phosphoric acid, or humus, and that the trees require little lime or magnesia. A high content of lime in the soil probably has a deleterious influence on the flow of latex. A good percentage of potash in the soil is said to be most advantageous to the growth of rubber trees and the production of latex.

Soil Sickness.—The results of two investigations on the cause of soil sickness are given in the *Journ. Agric. Science* (1912, **5**, 27, 86). The first paper, by Messrs. Russell and Golding, deals with sewage sickness, which manifests itself by the retarded rate of percolation of the sewage and the impure state of the effluent. It was found that the application of screened sewage direct to crops of mangolds and cabbage, growing in the sick soil resulted in the death of the plants. Examination of the field showed that where the sewage had, for a time, failed to percolate, there was a greenish-black slime containing algæ, euglena, and numerous other living organisms. The deflocculation of the clay caused by the alkaline nature of the sewage had also assisted in preventing percolation. Both these factors, however, can be eliminated by ploughing the land and applying dressings of lime. Examination showed that the bacterial activity was less than might be expected, and little increase in the number of bacteria was caused by

improving the physical condition of the soil. These facts pointed to the presence of some factor which tended to reduce the bacterial activity, and experiments showed that this could be overcome by partial sterilisation of the soil with antiseptics. When treated with carbon disulphide or toluene the number of bacteria rose from 20 to 30 millions up to 100 to 400 millions per gram of soil, and the rate of production of ammonia rose in a similar manner. The new bacteria, however, proved somewhat less vigorous than the old, but the soil no longer contained active amœbæ or other protozoa. These results indicate that the harmful effect is not due to plant toxins, but more probably to the presence of protozoa. Large-scale experiments, using 350 lb. of toluene or carbon disulphide per acre as a sterilising agent, gave satisfactory results, and when the practical difficulties of sterilising large quantities of soil have been overcome the method should be useful for sewage farms where slow decomposition is due to a deficiency of bacteria.

The sickness of glasshouse soils is the subject of the second paper, by Messrs. Russell and Petherbridge. It is well known that soils used for the intensive culture of cucumbers and tomatoes, although well manured, soon become sick and have to be replaced by fresh soil. In the case of cucumbers, this is often necessary after one season, but with tomatoes, where the culture is less intense, the soil often lasts five seasons. As these soils are highly manured, often being richer in plant nutriment than farmyard manure, considerable waste occurs by their being thus discarded. The sickness is often accompanied by insect and fungoid pests, one of which, *Heterodera radicicola*, produces the so-called "club" on the roots of both cucumbers and tomatoes. A consideration of other cases of soil sickness leads to the conclusion that it is associated with the high content of organic matter and water and the high temperature. The results of the authors' investigations show that the sickness is accompanied by a decreased bacterial efficiency due to the accumulation of some factor which is also present to a less degree in ordinary arable soils and can be put out of action by heat or antiseptics, and its properties are similar to those of protozoa. On a large scale the heat treatment (90–100° C.) can be carried out at a cost of about 1*s.* 6*d.* per ton of soil. The alternative treatment with antiseptics is much cheaper, and is said to promise greater possibilities of development, but the selection of a suitable agent is necessary: formaldehyde and certain tar oils appear to be suitable.

Foodstuffs

Wheat.—According to the *Rep. of the Minister of Agric., Canada*, 1911–12, p. 31, Marquis wheat, which has attracted attention in recent years on account of its early maturing,

prolific bearing, and rust-resistant properties, produced good results during the past unfavourable season. This was especially the case in Saskatchewan, where it surpassed the old standard variety, Red Fife, in strength of straw, earliness, yield, and quality, on almost every farm where it was grown. At the Indian Head Experimental Farm it has given an average yield during five years of 50 per cent. more than Red Fife. It is stated to be the best variety for the greater part of Saskatchewan, for Central and Northern Manitoba, and for large areas in Alberta. The Dominion Cerealist is producing supplies of a very early ripening variety named "Prelude," which has shorter straw, and ripens two weeks before Marquis, producing red kernels of high weight per bushel. "Prelude" yields flour with good bread-making properties, though not equal in colour to Marquis or Red Fife. It is intended for those districts where Marquis cannot be depended upon to ripen before the frosts occur.

Sugar.—The *Int. Sugar Journ.* (1912, **14**, 571) contains some notes on the Mozambique sugar industry (see also this BULLETIN, p. 102). There are seven factories in the country, which produced 27,700 tons of sugar in 1911, whilst three other factories are stated to be in course of erection. The area devoted to sugar-cane cultivation is about 31,300 acres, and about 11,000 native labourers are employed on the estates. The production represents 2½ tons per labourer, as compared with 3 tons in Natal. The crop varies from 25 to 30 tons of cane, and from 2 to 5 tons of sugar per acre, as compared with 30 to 35 tons of cane and 3 tons of sugar per acre in Natal. Only 800 tons of the output in 1911 were retained for local use, whilst 6,000 tons were exported to Portugal, 5,000 tons to the Transvaal, and the remainder to Greenock.

In a paper contributed by F. W. South at the West Indian Agricultural Conference, 1912 (*W.I. Bulletin*, 1912, **12**, 365), the possibility of applying Mendelian principles to sugar-cane breeding is discussed. As the different characters of the sugar-cane exhibit but slight variations, and at present there is no analytical knowledge of those characters that will behave as Mendelian units, the writer considers the Mendelian method too uncertain to come within the sphere of work of a sugar-cane experiment station.

The results of experiments with seedling and other varieties of cane are recorded in *Rep. Agric. Work, Barbados*, 1909–11, p. 16. The behaviour of the selected canes and statistics of their produce on various soils are set out in detail. Hybridisation experiments are described, and it is stated that progress has been made in the work of crossing seedling varieties of known parentage.

The *Rep. Sugar Indust. of Australia*, dated January 1910, which has been issued recently (December 1912), deals chiefly with questions of labour, excise, and bounties. The attempt to replace coloured labour by white labour has met with considerable success in Queensland, the percentage of sugar produced by white and coloured labour in 1908 being 87·89 and 12·11 respectively, the corresponding figures for 1902 being 14·45 and 85·55.

Coffee.—Owing to the preference shown by planters in Nyasaland for cotton and tobacco, the area under coffee cultivation during the season 1911–12 was less by 1,000 acres than that of the previous year (*Ann. Rep. Dept. Agric., Nyasaland*, 1911–12). In consequence, however, of the abundant rainfall during the year, the exports showed a marked increase, amounting to 796,304 lb., valued locally at £16,381, being double the value of the last season's crop. The average price for Nyasaland coffee on the home market was 67*s.* to 84*s.* per cwt. It is anticipated that on account of the drought very little coffee will be exported from the crop now approaching harvest, and a larger reduction in acreage is expected next year.

Bull. Écon. de Madagascar (1912, **12**, 1) contains an article on the cultivation of coffee in the Province of Mananjary. The chief variety grown is Liberian, which was introduced about fourteen years ago, whilst Canephora coffee is grown to a smaller extent. The Province exported 92 tons of coffee in 1910, and 125 tons in 1911. The cultivation, diseases, and preparation of the crop for the market are described. Canephora coffee is stated to be resistant to *Hemileia vastatrix*. It is a smaller plant than the Liberian, and yields a crop in the third year. The yield of berry represents one-fifth of the fresh fruit, as compared with one-tenth in the case of Liberian, over which it possesses the further advantages of being more easily prepared and commanding a higher price. Canephora coffee, however, requires shade and a rich soil, and gives a smaller yield. In the case of Canephora the fruits all ripen at the same time, and thus require but one harvesting. This variety matures earlier than Liberian, and it is therefore possible to grow the two varieties side by side, and harvest the two crops with the same staff of labour.

Tea.—The area under tea cultivation in Nyasaland has risen from 1,190 acres in 1910–11 to 2,593 acres in the following year (*Ann. Rep. Dept. Agric., Nyasaland*, 1911–12). A keen demand was manifested during the year for land within the rain zone of South-East Mlanje, but owing to the restricted area with a suitable rainfall the development of the industry is limited.

The *Journ. Roy. Soc. Arts* (1912, **60**, 1064) contains a

note on the tea industry of Java. In 1878 the cultivation of Assam tea was introduced into the Island, and has now entirely supplanted that of China tea. The output in 1900 was 6,600 tons, in 1905 11,228 tons, and in 1911 22,800 tons. The bulk of the crop is exported to Amsterdam and London, and in recent years large quantities have been shipped to Russia and Australia. *Der Tropenpflanzer* (1912, **16**, 439) describes the method of tea cultivation in Java, and contains statistics of production. The antipathy of the European planters towards the efforts of the Government to promote tea culture amongst the natives is discussed.

Cocoa.—According to information received from the Governor of the Gold Coast the cocoa crop of that Colony for 1912 was 86,197,151 lb., valued at £1,642,736. Although this represents a decrease of 3,285,075 lb. as compared with 1911, the quality of the cocoa has improved, the value showing an increase of £29,278.

Limes.—The statistics of the lime industry of Dominica (*Rep. Agric. Dept., Dominica*, 1911–12) show a decrease in the crop of 14,000 barrels of fruit as compared with that of 1910, which amounted to 369,000 barrels. The position of the industry is considered not unsatisfactory, as the crop of 1910 was much larger than that of 1909, and further, the total value of the exported limes and lime products during 1911 amounted to £73,882, an increase of £3,548 over that of the previous year. The export of green limes has grown from 15,799 barrels in 1906 to 36,520 barrels in 1911, whilst the export of citrate of lime for the same years is 733 cwt., value £1,503, and 5,926 cwt., value £19,259, respectively. In the report attention is drawn to the necessity of good drainage to prevent root disease. It is also stated that the success of the cultivation is in a large measure due to the prevalence of certain species of fungi which attack the various scale insects affecting citrus trees.

Oils and Oil-Seeds

Coconuts.—Cochin copra has always fetched very high prices, and according to Dupont (*Report on a Visit to India, etc.*, 1912, p. 46) this is due to the fact that the merchants who buy from the natives pick out all defective or dark coloured material and use this for preparing oil, only the selected copra being exported. The average rainfall is 115 in. and the mean temperature 82° F.

The "tapahan" method of drying copra is largely used in the Philippine Islands (*Philippine Agric. Rev.*, 1912, **5**, 617). In this method the copra is dried by means of fires composed of coconut husk and shell, and much of the copra is damaged by smoke owing to the use of damp husks.

There is a tendency now to use only shells which cause less smoke and damage, but the best method is to protect the copra from the smoke, which is produced after the fires are lighted, by means of sheet iron or by mats which can be removed when the fires have ceased to give off smoke and are burning brightly. In Laguna two steam drying plants have been started by a Filipino planter, and excellent copra is being produced; the apparatus used is a modification of a drier worked by the Bureau of Agriculture at the first Philippine Exhibition at Manila. The steam drier has also been found useful for drying copra which has been insufficiently dried by the "tapahan" process and has commenced to rot.

Information regarding many lesser-known insects attacking coconut palms is given in an article by Zacher in *Der Tropenpflanzer* (1912, **16**, 484).

The composition of coconut oil has been investigated by Elsdon (*Analyst*, 1913, **38**, 8), with results similar to those already obtained by other observers; the author is investigating palm kernel oil in the hope of finding a means of distinguishing this oil from coconut oil.

Linseed.—Trials with this crop in Rhodesia have been successful, and two varieties, viz. Pskoff and Yellow-seeded, which bear evenly ripening seed, have been obtained (*Rhodesia Agric. Journ.*, 1912, **10**, 15). This overcomes the difficulty experienced in previous trials with plants bearing seeds ripening over a long period; the Pskoff variety has also been found to mature several weeks earlier than other kinds. Rhodesian grown linseed has been favourably reported on in England, and farmers in Rhodesia are now recognising its value for feeding stock. The cost of exporting is high, but assuming an average crop of 3½ bags per acre, as was obtained in the trials, it is calculated that, after paying freight charges, £2 to £3 per acre should be obtained to cover cost of production and profit; this, it is stated, compares not unfavourably with the returns obtained from maize on most kinds of soil.

Oil Palm.—Attempts are being made to induce the natives to exploit the oil palms more thoroughly in the Duala district of Togoland; this question is fully discussed by Reder in an illustrated article in *Deutsches Kolonialblatt* (1912, **23**, 948).

A machine has been patented by Buchanan and Tyrell for removing the pericarp from palm and other fruits (U.K. Pat. 10,335, Feb. 9, 1911). It consists essentially of a stationary, elongated, horizontal cylinder, composed of triangular bars through which the palm fruits are fed by means of beaters mounted on a central shaft. The oily pericarp passes through the spaces between the triangular bars, whilst the nuts are carried to the end of the cylinder,

and pass thence into a rotating wire cage, in which any pulp which remains on the nuts is removed. The central shaft may be hollow and so arranged that steam can be applied to the fruit inside the cylinder. The triangular bars are sharpened at the edges and are so mounted that they can be set at any suitable angle or turned so as to present a new edge when one becomes blunted.

An apparatus for the extraction of oil from palm or other fruit has been patented by Hawkins (U.K. Pat. 20,061, Sept. 9, 1912). In this apparatus the fruit is placed in a circular rotating pan or upon an endless travelling bed, above which is a framework bearing stationary, serrated baffles and pipes for the delivery of superheated steam or solvents, and also rollers for pressing down the mass of fruit in the pan. In operating this machine the fruits are fed into the circular pan, which is then caused to rotate. The fruits are thus brought into contact with the serrated baffles and with steam or solvents. The baffles, etc., are so mounted that they can be gradually lowered into the pan and thus disintegrate the pulp thoroughly. The outer wall of the pan is perforated, to allow the oil to flow into an outer collecting gutter.

Para Rubber Seeds.—It is reported that a factory has been established in Ceylon for decorticating Para rubber seed (*Trop. Agriculturist*, 1912, **39**, 251). £3 per ton is the price offered to rubber estates for seed.

Shea Nuts.—Experiments are being carried out at Koulikoro on the Niger with a view to ascertain (1) the average yield of shea nuts per tree, (2) the amount of fat in kernels taken from the same tree at different periods, (3) the amount of fat contained in kernels of different varieties (*Journ. d'Agric. Trop.*, 1912, **12**, 283). In 1911 twenty trees of varying size gave yields of dry nuts varying from 1¾ lb. to 85 lb. per tree. The amount of fat in the seeds taken from the tree when in full bearing was found to be 2 to 3 per cent. in excess of that in seeds gathered before or after this period. It was also found that the kernels of some varieties are richer in oil than others.

Shea trees are spread over the whole of the Sokode-Bessari district of Togoland, but are specially abundant on the steppes of Dagombaland. (*Mittl. aus den Deutschen Schutzgebieten*, 1912, **25**, 285). The residual kernel meal from which the shea butter has been prepared is used by the natives to smear on their mud huts to render them rain-proof.

Sunflower Seed.—Since about 1845, sunflower seed has been grown on a large scale in Russia, where the seeds are used for food and as a source of oil and feeding cake (*Diplomatic and Consular Repts.*, *Ann. Series*, No. 4965

[Cd. 6005–138], 1912, p. 22). Fairly moist, well drained soil is most suitable, and plenty of rain is necessary during the growth and flowering of the plant, after which period dry, warm weather is needed until the harvesting of the seed. Yields of seed up to 18 cwt. per acre are obtained, but the usual yield is probably only about 7 to 8 cwt. per acre. The seeds are planted 2 to 3 ft. apart in both directions, or in rows 40 in. apart in which the plants are 20 in. apart. The leaves are generally allowed to remain on the stems, but lateral flowers are removed to encourage development of the terminal flower.

After harvesting, the seeds can be removed from the heads by shaking when the season is very dry or the seeds are over-ripe; otherwise the heads must be stacked or hung up to dry, the seeds being then removed by shaking, beating, or rubbing two heads together. Machines devised for removing the seed from the flower-heads do not appear to have been very successful, and the use of such machines has been largely abandoned, although wooden rasps or wire netting are sometimes employed. The use of appliances is unnecessary with those varieties of sunflowers having easily separable seed, and it seems advisable to recommend the selection and planting of these varieties. Good, dry sunflower seed is estimated to yield 18 to 24 per cent. of oil when the husks are removed before pressing, while 14 to 18 per cent. is obtained when unhusked seed is pressed. The proportion of husk to kernel varies in the different varieties of sunflower seed.

Beeswax.—Ghedda or East Indian wax has been found by Lipp and Kuhn (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1912, **19**, 273) to differ from ordinary beeswax in containing the ester of ceryl alcohol alone, whilst beeswax also contains the ester of myricyl alcohol.

Miscellaneous.—The fruits of a species of *Trachylobium*, probably *T. Mossambicense*, Klotsche (= *T. Hornemannianum*, Hayne), belonging to the order Leguminosæ, which is one source of East African copal, have been found to contain 46 per cent. of oil in the kernels, which, however, constitute only 11·2 per cent. by weight of the fruits. The outer pulp comprises 41 per cent. by weight of the fruit, and contains 17·8 per cent. of oil (*Journ. d'Agric. Trop.* 1912, **12**, 233). The kernel oil is described as a semi-drying oil of golden yellow colour and unpleasant smell. The tree is said to occur frequently in the extra-tropical region of Mozambique, and to a less extent in the tropical region, but no information as to the possibility of obtaining commercial supplies of the seed is given.

In the *Agricultural Ledger*, No. 5 of 1911-12, Hooper deals briefly with the sources, characteristics, production, and uses of the oils and fats of India.

"Perah" seeds, derived from *Elateriospermum Tapos*, Miq., a large tree belonging to the Euphorbiaceæ, said to be common in Perak, Selangor, and Pahang, have been found by Barrowcliff (*Agric. Bull, F.M.S.*, 1912, **1**, 178) to contain 39 per cent. of light yellow liquid oil of pleasant taste, while the press cake was found to contain cyanogenetic glucosides. No information appears to be available as to the age at which the trees bear seed or as to the possibility of obtaining commercial supplies.

A trial shipment of forty tons of Munkuetti nuts (cf. this BULLETIN, 1911, **9**, 405) has been sent from German South-West Africa to Europe (*Board of Trade Journ.* 1912, **78**, 751). If the results of trials are favourable it is intended to erect an oil-extracting plant near Tsumeb. The nuts appear to be non-poisonous, as they are eaten by the natives. According to Grimme (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1913, **20**, 1) the seeds consist of about 63 per cent. kernel and 37 per cent. shell. The kernels contain about 57 per cent. of drying oil, which should be suitable for paint, varnish, or soft soap manufacture.

Djave nuts (cf. this BULLETIN, 1908, **6**, 373; 1911, **9**, 157) have been examined by Wagner and Ostermann (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1912, **19**, 249), who obtained results with the fat agreeing with those obtained by previous observers. They agree with Fickendey in stating that the seed residue after removal of the oil is not poisonous.

Holde and Meyerheim (*Chem. Rev. ü. Fett. u. Harz. Ind.* 1912, **19**, 302) have examined the oil of *Plukenetia conophora*, Muell. Arg. (Euphorbiaceæ), and have obtained analytical figures according fairly closely with those yielded by linseed oil; the oil also dries almost as rapidly as linseed oil (cf. this BULLETIN, 1912, **10**, 494).

"Galip" nuts from New Guinea have been found to consist of about 80 to 85 per cent. shell and 15 to 20 per cent. kernel, containing 65 to 71 per cent. of oil. The nuts are probably derived from *Canarium commune* (*Verh. Kolonial. Wirtsch. Kom.* 1912, No. 2, p. 74).

ESSENTIAL OILS

Turpentine Oil.—In the *Report on Forest Administration in the Western Circle of the United Provinces for* 1911–12 it is stated that, in the Naini Tal division, though fewer pine trees were tapped, the outturn of crude oleo-resin showed an increase of 1,725 maunds (1,263 cwt.) for the calendar year 1911, as compared with 1910. The new method of tapping, introduced in 1910–11, using a channel of curved cross-section, has proved so satisfactory that in future it will be generally adopted. A new steam distillation plant has been purchased and erected at the Bhowali distillery, and trials show that good results may

be expected in the cost of working and in the yield and quality of the products. The amount of oleo-resin collected in this district during the year ending July 1912 was 19,669 maunds (14,460 cwt.), yielding 26,739 gallons of turpentine oil and 11,826 maunds (8,658 cwt.) of rosin.

In Kumaun the prospects of the industry are promising. Tapping operations are being largely extended, and a yield of 30,000 maunds (22,000 cwt.) of oleo-resin is expected for the year 1912.

In the Chakatra division also satisfactory results have been obtained; though fewer trees were tapped than in the preceding year, there was a higher yield of oleo-resin.

Star Anise Oil.—In an article entitled "La Badiane au Tonkin," by M. Philippe Eberhardt in *Annales de la Drogue et de ses dérivés* (1912, **10**, No. 22, p. 28), a detailed account is given of the present state of the star-anise industry in Tonkin. Until recently little has been done in the systematic cultivation of *Illicium verum*, which yields this oil. Formerly, the natives sowed the seeds round their dwellings and gave the plants little or no attention other than harvesting the fruits. They now recognise the advantage of rearing the young plants in nurseries and subsequently transplanting them. The young plants are shielded from the heat of the sun, to which they are very sensitive, by training Cucurbitaceæ over a bamboo framework erected above them. For satisfactory growth they require a deep soil, rich in humus. Considerable losses are suffered through the neglect of the natives, who do not water the plants after transplanting them. The distance which should be left between the plants to ensure satisfactory development is eight metres, but they are often planted with an intervening space of only five metres, or even less. The distillation of the fruits, which is described in full, is carried out in earthenware stills of Chinese origin. M. Eberhardt suggests that the leaves also of the plant should be distilled. The leaf oil has rather a low congealing point (13°–14° C.), but he thinks it could be mixed judiciously with the oil from the fruits, which often has a congealing point of 17°–18° C., to bring the congealing point to the commercial standard of 16° C. Consumers of this oil in Europe are not likely to view this suggestion with favour.

Australian "Sassafras" Oil.—An investigation of the oil of the leaves of *Atherosperma moschata*, Labill., the "Australian sassafras," natural order Monimiaceæ, is published in the *Journ. Chem. Soc.* (1912, **101**, 1612). The main constituent of the oil is eugenol methyl ether, which is present to the extent of 50 to 60 per cent.; 15 to 20 per cent. of pinene and of *d*-camphor, and 5 to 10 per cent. of safrole, are present. The tree, which is quite distinct from *Sassafras*

officinale, is stated to grow luxuriantly in the mountain gullies around Healesville and Warburton in Victoria.

RUBBER

The production of rubber in North Madagascar is the subject of an article by H. Hamet and L. Josse in *l'Agric. prat. des Pays chaud* (1912, **12**, 265). The chief rubber-producing plants are the following (compare this BULLETIN, 1911, **9**, 162): *Landolphia madagascarensis*, which yields a latex coagulable in the cold by 5 per cent. sulphuric, citric, and other acids, and by common salt on heating. The rubber is pinkish, and rapidly darkens in the air. The yield varies from 6 to 25 per cent. of the latex, according to the season, the age of the plant, and part of the plant from which the latex is obtained. The commercial value of the rubber is 60 per cent. of that of Para. *L. Perrieri* yields an abundant latex, which is coagulable by the same means as above. The rubber is of excellent quality, but the yield is poor. *L. sphærocarpa* yields abundant latex, containing 18 to 26 per cent. of rubber of excellent quality. *L. tenuis* also yields a rubber of good quality. *Cryptostegia madagascarensis* yields an easily coagulable latex, containing 15 to 20 per cent. of rubber, but the adult branches only should be tapped. *Marsdenia verrucosa* yields abundant latex, containing 10 to 12 per cent. of rubber, of very poor quality. *Mascarenhasia anceps*, *M. longifolia*, and *M. utilis* yield the "black rubber" of Madagascar, the commercial value of which is 50 to 60 per cent. of that of Para. The authors describe the habits and distribution of the above species in the north of Madagascar, and the methods employed for preparing the rubber, and suggestions are made for improving the quality of Madagascar rubber.

The same *Journal* (1912, **12**, 425) contains a description by H. Jumelle and H. Perrier de la Bathie of the *Mascarenhasia* spp. of East Madagascar.

Der Pflanzer (1912, **8**, 433) contains a detailed account, by E. Marckwald and F. Frank, of an examination of samples of Ceara rubber from East Africa. They examined forty-one samples which had been prepared with different reagents, either by coagulation on the tree or by coagulating the collected latex. Amongst the reagents used in the two sets of experiments were 1 to 2 per cent. solution of calcium chloride, purub, or lactic acid, 5 per cent. citric acid solution containing 1 per cent. of calcium phosphate, acetic acid containing 0·5 per cent. of phenol, 10 per cent. citric acid solution containing 5 per cent. of calcium phosphate, and lastly boiling water.

The viscosities of solutions of the raw rubbers were determined, and the samples were also vulcanised and tested for elasticity and strength by means of the Schopper

apparatus. The quality of the corresponding samples furnished by the two methods did not agree in most cases.

The authors remark that working of the rubber, such as crêping on the plantations in East Africa, is not attended with good results. It was found that rubber coagulated by means of calcium chloride cannot be afterwards washed free from chlorine. The juice of the wild lemon, where obtainable, is regarded as the best means of coagulating the rubber on the tree, and citric acid solution containing magnesium salts or calcium phosphate as the best means of preparing rubber from collected latex.

Hevea brasiliensis.—*The Report Agric. Dept., Gold Coast,* 1911 (p. 8), contains an account of experiments on the cultivation of Para rubber at the Aburi and Tarquah agricultural stations.

A table is given showing monthly yields from tapping experiments at Aburi. It was found that considerable diminution of yield follows continuous tapping for 18 months, but that the dry season or wintering of the trees does not materially affect the yield. An average yield per tree of 2 lb. 1·9 oz. of dry rubber was obtained for the whole year with 152 tappings. Yields from renewed bark give indications of being greater than those from the original bark. At Tarquah better results were obtained. Thirty trees planted 15 × 15 ft. apart gave an average yield of 3⅓ lb. dry rubber per tree for the whole year. One thousand trees, however, planted 12 × 12 ft. apart, gave an average of only 1½ lb. dry rubber per tree for 10 months' tapping. This was thought to be due probably to too shallow tapping. The rubber obtained in the experiments was sold at 4*s.* 9¾*d.* per lb., with fine hard Para at 4*s.* 8*d.* per lb. and plantation Para at 5*s.* per lb. The cost of production of Para rubber in the Gold Coast is estimated at considerably below 2*s.* per lb. *Hevea brasiliensis* also shows satisfactory growth at Coomassie and Assuantsi, where many trees are nearly ready for tapping.

"The Nitrogenous Constituent of Para Rubber" is the title of a paper by C. Beadle and H. P. Stevens in the *Journ. Soc. Chem. Indust.* (1912, **31**, 1099). Sheet rubber was allowed to swell in benzene and the solution separated by decantation from the undissolved portion, and the benzene evaporated from each. The solution gave a rubber of pale golden colour, containing practically no nitrogen; the insoluble portion gave a darker coloured product, rich in nitrogen. The samples of rubber thus obtained were vulcanised under the same conditions as (1) a sample of the original rubber and (2) a sample which had been obtained by allowing the original rubber to swell in benzene and evaporating off the benzene. The vulcanised rubbers were tested by the Schwartz machine.

It was found that the amount of "combined sulphur"

and degree of vulcanisation effect was dependent on the proportion of insoluble matter as measured by the percentage of nitrogen in the rubber, *i.e.* the combined sulphur was highest when the nitrogen content was lowest. The mere swelling of the rubber in the solvent, with subsequent removal of solvent by evaporation, was without effect on the quality of the rubber. The vulcanised product from the nitrogen-free rubber was much more distensible than that from the other samples, but its tensile strength and other physical properties were decidedly inferior. The conclusion is drawn that synthetic rubber, being free from insoluble nitrogenous matter, would be inferior to the natural product. The authors state that the removal of "resin" also results in a deterioration of the quality of rubber.

Funtumia elastica.—The *Report Agric. Dept. Gold Coast*, 1911, p. 10, gives the results of experiments on the tapping of *Funtumia elastica* at Aburi, designed to test (1) the best time to tap, (2) the comparative yields from trees of different girths, (3) the average yields per tree at the first and subsequent tappings. The vertical parallel system of tapping was adopted as being the most easily adapted to the experiments. The results are tabulated, and indicate that the period June to December or January is the best time to tap. Tapping at intervals of two months gave a total yield of rubber almost as large as tapping at four or six months' interval. The largest trees gave the largest yields of rubber. The average yields per tree at the first and subsequent tappings, at 2 months' intervals, were:

	Latex. *C. cm.*	Dry rubber. *Grams.*
1st tapping (October)	37·2	17·7
2nd „ (December)	28·1	11·7
3rd „ (February)	15·5	8·5

Although the incision method of tapping was employed, the wounds did not heal up well, and it is still uncertain how soon re-tapping can be profitably commenced. The yields from Funtumia in the Gold Coast are poor and compare unfavourably with those from Hevea. However, it is easily cultivated and can be grown in semi-dry regions where Hevea does not thrive.

Oxidation of Rubber.—The action of gaseous oxygen on indiarubber has been studied by S. J. Peachey (*Journ. Soc. Chem. Indust.* 1912, **31**, 1103). A thin film of purified rubber of known weight was deposited from pure benzene solution on the interior surface of a flask which was connected with a measuring apparatus, and the whole filled with oxygen. The flask was immersed in water, and maintained at a temperature of 85° C. until absorption of oxygen ceased.

It was found that the volume of oxygen absorbed corresponded to four atoms of oxygen for every $C_{10}H_{16}$ complex. This result is contrasted with that of Herbst (*Ber. d. d. chem. Gesell.* 1906, **39**, 523), who found that on passing air for a prolonged period through a heated benzene solution each $C_{10}H_{16}$ complex absorbed one atom of oxygen (cf. also this BULLETIN, 1912, **10**, 675). The presence of "resin" (3 per cent.) in the rubber exercised very little influence on the total volume of oxygen absorbed, but greatly retarded the rate of oxidation.

FIBRES

A recent supplement to *Der Tropenpflanzer* (*Beihefte*, Nos. 5–6, 1912) is devoted to a full and well-illustrated account, by Dr. W. F. Bruck, of the cultivation and preparation of fibres in the Dutch East Indies and the Philippines. The work consists to a large extent of original observations made by the author during a visit to these countries in 1911. The products dealt with in connection with the Dutch East Indies are Manila hemp, kapok, Java jute (*Hibiscus cannabinus*), and the fibres of *Agave* spp. (cf. this BULLETIN, 1912, **10**, 301). The Philippine fibres include Manila hemp, "Maguey" (*Agave Cantula*, Roxb.) and pineapple fibre.

African Wild Silk.—Reference to the wild silks of Africa has been made previously in this BULLETIN (1907, **5**, 438; 1910, **8**, 150; 1911, **9**, 412). There are three kinds of silkworm occurring in the wild state in Uganda, viz. *Anaphe infracta*, Walsm., *Hypsoides milleti*, de Juan, both belonging to the Eupteridæ, and *Mimopacha gerstaeckeri*, Dew., of the Lasiocampidæ. The first of these is the most common, although not particularly abundant, whilst the last is comparatively rare. In the *Ann. Rep. Dept. Agric., Uganda Protectorate*, for 1910–11, an account is given of some experiments carried out on the domestication of *Anaphe infracta*, and the life-history and habits of the insect are described. The plants on which the insect feeds are *Bridelia micrantha*, *Cynometra Alexandri*, and *Triumfetta macrophylla*. The experiments were made with *Bridelia micrantha*; the trees should be planted 6 ft. apart, and when they are large enough to support a colony of silkworms, the larvæ may be introduced either by tying a cocoon-mass on the tree, or by placing the eggs on the leaves.

Paper-making Materials.—Attention has been drawn recently to the possibility of utilising *Hedychium coronarium*, of the natural order Zingiberaceæ, for paper-making (*Kew Bulletin*, 1912, No. 9, 373). This plant is indigenous to India, and also occurs in Central America, the West Indies, New Zealand, and West Africa. It has been introduced into Brazil, and is now abundant in the wild state in many parts of the country, and especially at Morrettes in the State of

Parana. The plant spreads rapidly by means of creeping rhizomes, from which spring numerous leafy stems. The stems have been investigated by Messrs. Clayton Beadle and Henry P. Stevens, who have reported that they yield a useful fibre, and can be converted into paper which is very strong and exceptionally elastic (*Reports of the Eighth International Congress of Applied Chemistry*, 1912, **13**, 39). If the cells are allowed to remain in the pulp with the fibres, the paper produced is very strong and of a parchment-like character; but if the cells are removed, the paper is of a soft nature and medium strength. The yield of pulp containing both cells and fibres is about 60 per cent. of the weight of the air-dry stems, whilst that containing fibres only is about 50 per cent. The fibres have an average length of about 0·1 in.

Reference is also made in the *Kew Bulletin* (1912, No. 9, 377, 396) to three other plants which have been examined by Messrs. Clayton Beadle and Stevens. The stems of *Amomum hemisphericum* and *Alpinia nutans*, both plants of the natural order Zingiberaceæ, yield 58·2 per cent. and 50·0 per cent. of fibre respectively (calculated on the dry stems). In each case the fibre would be quite serviceable for paper-making, although inferior to that of *Hedychium coronarium*. The third plant is Marram grass, which is commonly grown on the sand-hills of the coasts of the United Kingdom, and could be readily cultivated on extensive tracts. The dry grass yields 31·4 per cent. of unbleached pulp, which somewhat resembles that obtained from esparto grass.

Cotton

Egypt.—According to the *Monthly Return of the Egyptian Cotton Crop* (1912, No. 1), the area under cultivation (as registered by the returns of the Direct Taxes Department) amounted in 1911 to 1,711,241 feddans, and in 1912 to 1,721,815 feddans (1 feddan = 1·038 acres). The varieties grown and the percentage of the total area occupied by each were as follows: In 1911: Mitafifi, 49·4; Yannovitch, 14·7; Nubari, 6·8; Sakellaridis, 7·0; Abassi, 1·9; Ashmouni, 19·3; Voltos and other varieties, 0·9. In 1912: Mitafifi, 40·2, Assil, 2·3; Yannovitch, 13·9; Nubari, 9·2; Sakellaridis, 11·5; Abassi, 2·1; Ashmouni, 20·0; Voltos and other varieties, 0·8.

The cotton crop of 1911–12 was superior to that of 1910–11 in quantity, but was inferior in quality, owing to excessive heat and a deficiency of water at the critical period of growth, and to subsequent overwatering at the time of the floods. The Mitafifi cotton shows a continuous decline in colour, quality, and yield, and the seed is impure. Extra fine qualities are scarce, the proportion of "dead" (immature) cotton increases, and the crop is often mixed with Nubari.

The Assil variety (this BULLETIN, 1911, **9**, 409) has not altogether fulfilled the expectation that it would replace Mitafifi; it appears to be related to Nubari rather than to Mitafifi. The Yannovitch cotton has deteriorated, and the seed has become impure. The Nubari variety has undergone a striking deterioration in quality, and very little of the extra fine grade is produced. The Sakellaridis cotton (this BULLETIN, 1911, **9**, 288) is the best now grown in Egypt, and in good districts has maintained its quality. The Abassi variety has deteriorated to some extent, and is being largely replaced by Voltos cotton. The latter variety gives good yields; it resembles Abassi, but is stronger and of a more creamy colour.

Northern Nigeria.—It has been stated previously (this BULLETIN, 1912, **10**, 480) that since the completion of the Baro-Kano Railway the exports of cotton from Northern Nigeria have shown a striking increase. The total quantity purchased by the British Cotton Growing Association in 1912 amounted to about 2,500 bales, of 400 lb. each, a great advance on any previous year.

During October and November 1912 one of the Association's officers made three tours in the Zaria Province, and encouraged the farmers to extend the area devoted to the crop. He was greatly impressed with the prospects of cotton-growing in some of the districts through which he passed, and was led to the conclusion that the output of the Zaria ginnery in 1913 will approximate to 7,000 bales as against 2,135 bales in 1912.

Mauritius.—Experiments in cotton-growing have been carried out in Mauritius, and have afforded valuable information, although they have not led to definite conclusions (cf. this BULLETIN, 1912, **10**, 501). An account of the more recent work is given in the *Rapport Annuel pour* 1911, *Station Agronomique, Mauritius.* Serious losses were occasioned by cyclones, which are of common occurrence in the island, and it is considered that a season wholly favourable to cotton would be quite exceptional. Nevertheless, it is thought that the cultivation might be possible under certain conditions; but, unfortunately, it is difficult to procure the necessary labour, on account of the more profitable employment afforded by the sugar plantations.

India.—A study of the seed supply of certain districts of the Bombay Presidency has shown that the cotton seed used by the ordinary cultivators is very inferior (cf. this BULLETIN, 1911, **9**, 410). In this connection, an account of "A Method of Improving the Quality of Cotton Seed" has now been published as *Bull. No.* 53, 1912, *Dept. Agric., Bombay.* It has been found that the germinating power of the seed can be enhanced by separating the heavy seeds

from those which are light and damaged. This may be effected by the method devised in the United States, and described in this BULLETIN (1908, **6**, 74).

Tunis.—Efforts are being made in Tunis, under the auspices of the French Colonial Cotton Association, to ensure the purity of the seed employed for sowing in order that the crop may be of a homogeneous character, and therefore of greater value (*Journ. d'Agric. Trop.* 1912, **12**, 378). The Administration have decided to adopt a measure compelling planters to uproot, or permit to be uprooted, any plants in the field which do not conform to the type of the variety under cultivation; by this means hybridisation will be prevented. In certain cases the planters will receive compensation. The Administration reserves to itself the right of purchasing the seed. This system has met with the approval of nearly all the planters.

German East Africa.—During the year 1912 considerable apprehension was aroused in Mwansa, German East Africa, by the occurrence of a peculiar disease affecting the leaves of the cotton plants. The disease was first recognised by the appearance of a shiny incrustation on the upper surface of the leaves; in some instances tiny drops of similar material were noticed on the hairs on the lower surface. This affection, termed the "Mafuta" disease, has been studied by Dr. Kränzlin, and an account of his work has been published in *Der Pflanzer* (1912, **8**, 640). It has been proved that the incrustation is not formed by the leaves themselves, but consists of the excrement of a certain insect. The extent to which the plants are injured by the disease has not yet been established, but probably it is not very serious. In order to check the spread of the insects, it is suggested that the first plants which are attacked should be destroyed. The best remedy, however, is to ensure that the plants are grown under such conditions that they can undergo strong and healthy development, since it has been found that they are then more resistant to the insects, and the latter are not able to multiply greatly.

TOBACCO

The manurial experiments with tobacco conducted during the year 1910–11 in Java, are described in detail in *Mededeelingen van het Proefstation voor Tabak*, No. V. The chief problem was to ascertain in which of the three principal nutrients—nitrogen, potash, and phosphoric acid—the soil was most deficient. In interpreting results the improvement in quality and colour of the leaf as well as the yield was considered. The application of artificial manures, containing varying amounts of the three constituents just mentioned, showed that the least increase

in yield over unmatured ground was obtained when nitrogen was omitted from the manure, and that a mixture of nitrogen and potash was the most beneficial.

The manure employed consisted of 3 grams sulphate of ammonia, 1½ grams superphosphate, and 1½ grams sulphate of potash per plant; but it was found that the application of twice this quantity not only doubled the increase in yield in many cases, but also effected a great improvement in the colour and quality of the tobacco. Further experiments, to ascertain the largest amount which it is profitable to apply, are being proceeded with.

Trials to compare a mixed manure, sold under the name of "tobacco guano," with a prepared manure of the same potash, nitrogen, and phosphoric acid content, showed that practically the same increase was obtained in each case; but the cost of the prepared manure was only slightly more than half that of the "guano." Comparative trials of the value of nitrogen as an ammonium salt and as a nitrate are in progress. These experiments, and others with native manures (bat guano and night soil), are not yet sufficiently advanced to justify conclusions being drawn.

According to the *Ann. Rep. Dept. Agric. Nyasaland*, 1911–12, the tobacco crop amounted to over 2,000,000 lb., equivalent to 2 per cent. of the tobacco consumed in the United Kingdom during 1911. This source of supply is attracting considerable attention, but some difficulty has been experienced in persuading manufacturers to use Nyasaland tobacco in place of "Virginian" leaf, although the former may be equal in quality. Attention is drawn to the damaged condition in which large bales arrive from Nyasaland. The tobacco in small bales, 2 ft. 6 in. by 2 ft. 6 in. by 2 ft., compared favourably with that from the United States, which is packed in hogsheads.

The annual tobacco crop of Madagascar, exclusively a native cultivation, is estimated at about 800 tons (*l'Agric. prat. des Pays chauds*, 1912, **12**, 192). It consists entirely of indigenous varieties, chiefly hybrids, of which the principal one, known as "Jilo," has short, straight, pointed leaves. The total crop is consumed locally, and about 15,000 lb. is imported from Réunion, Algeria, France, Natal, and Egypt. Methods of cultivation and particulars of the local markets are given.

Information on the growing and preparation of "bright" tobacco under local conditions is given in an article in the *Rhodesia Agric. Journ.* (1912, **9**, 675). It is stated a sandy soil is the most suitable, usually derived either from granite or sandstone, and in the opinion of the author, the poorer the soil, the brighter the leaf produced. The results on heavy, rich soil have been disappointing, and the product only saleable at unremunerative prices. Particulars for the

production of a continuous supply of seedlings are given. Details of transplanting and treatment in the field follow, together with a description of harvesting and preparation. These points are dealt with in an article in this BULLETIN (1910, **8**, 172). The author considers that it is not advisable to grow tobacco more than three consecutive seasons on the same land, as the colour of the leaf darkens each year under such conditions.

Bulletin No. 241, 1912, *Bur. Plant Ind., U.S. Dept. Agric.* deals with the use of artificial heat in the curing of cigar-leaf tobacco. It is stated that the application of artificial heat under proper conditions does not injure the quality of cigar tobacco, but, on the contrary, insures better curing, especially as regards the colour of wrapper-leaf tobaccos. Open charcoal fires are used extensively in the Connecticut Valley in curing shade-grown tobaccos, but the fuel is expensive, and the management of the large number of small fires required for the purpose needs much time and care. A method of heating by means of flues and a system of ventilation are described. The details of construction of the plant employed are given, and it is stated that excellent results have been obtained. By the use of artificial heat the planter is no longer dependent on climatic conditions, but can adjust the heating and ventilation to obtain the desired effect.

FORESTRY

Tasmanian Forests.—The Report for the year ending June 30, 1911, by the chief forest officer of the Forest Branch of the Department of Lands and Surveys, Tasmania, states that the total amount of revenue received by the Department from all sources under this head for 1910–11 was £4,366, or £526 in excess of the amount for 1909–10. The timber exported during 1910 amounted to 9,547,976 superficial feet, of value £47,136, and the production during the same period was 54,483,198 superficial feet of sawn timber, valued at £193,081. The greater portion of the timber produced in Tasmania is shipped to various parts of the Commonwealth. A consignment of iron-bark sleepers, comprising 1¼ millions of superficial feet of timber, was forwarded to Bombay, the greater part of the timber being obtained from the sea coast. The manufacture of furniture from Tasmanian hardwoods is making rapid advancement. The timbers used for this purpose are stringy-bark and another eucalypt commonly known in the trade as "Tasmanian Oak." The total area of land held from the Crown for the purpose of obtaining timber on payment of royalty is 110,772 acres.

Forests of the Ivory Coast.—In *l'Agric. prat. des Pays chauds* (1912, **12**, 334) are given the regulations, laid down

by the French Government in June 1912, for the exploitation of the Ivory Coast forests. The regulations, which are sixty in number, deal with the conditions and methods of working both the Government and privately-owned woods and forests, the rights and privileges of the natives in the Government forests, the suppression of offences, and with the disposal of timber felled or products collected contrary to these regulations.

Teak (*Tectona grandis*).—In the German colony of Togoland teak has been planted at all the forestry stations. According to a *Report on the Afforestation of Togo*, 1912, by A. H. Unwin, the total area under teak is about 900 acres. The situation of the plantations varies from 50 to 1,800 ft. above sea-level, and the trees are found to thrive in almost any kind of soil, with the exception of swampy areas and very poor sandy soil over an iron-stone pan. The trees for planting about half the area were raised in nurseries, the others from seed planted *in situ*; the former have given the better results. From their first to their fifth year the trees grow rapidly, but after this period their growth in height slackens. Small crops of seed are produced in the third and fourth years after planting, and good crops in the fifth and following years. Some of the areas under teak are pure plantations, others are mixed. The species used for growing in association with teak are ebony (*Diospyros mespiliformis*), West African rubber (*Funtumia elastica*), iroko (*Chlorophora excelsa*), African mahogany (*Khaya senegalensis*, and the allied species, *K. Klainii*), and sasswood (*Erythrophlœum guineense*). The object of planting other trees is to protect the soil during the period when the teak trees shed their leaves.

The Togoland plantations are to be treated as "high forest," and are to be worked under a rotation period which has been provisionally fixed at eighty years. The estimated average cost of the plantations in their second year is £3 per acre.

In Deli, on the east coast of Sumatra, teak is employed in the construction of drying-sheds for tobacco. An account of these structures and the utilisation of teak in this connection is given in *Journ. d'Agric. Trop.* (1912, **12**, 268). The teak piles are obtained from young trees ten to fifteen years old, grown from seed, and the rafters from which the tobacco is suspended from trees five to six years old. The piles are from 30 to 36 ft. in length, and have a diameter at the base of from 8 to 12 in., or sometimes even 14 in. After being cut down to the ground the young teak trees reproduce themselves very quickly, and in from three to four years the coppice shoots are sufficiently large to be of use in the construction of drying-sheds, especially if care be taken to remove the bark, which is very thick

and useless. Other kinds of timber which are similarly employed in Sumatra are furnished by species of mangroves which occur in salt soils near the sea, and by *Casuarina equisetifolia*, a quick-growing tree which is planted by the road-sides in Deli for shade.

The growing scarcity of teak, and the consequent rise in price of this important timber, necessitates finding substitutes. In the notice of a paper by Mr. E. V. de Coque (*Trop. Agric.* 1912, **39**, 161) the following timbers, which occur in the Dutch East Indies, are recommended as teak substitutes: Tempenis (*Sloetia sideroxylon*), balau (*Parinarium oblongifolium*), and a species known locally as "ironwood." Tempenis and balau also occur in the Malay Peninsula, and specimens of these timbers may be seen in the British Malaya Court of the Public Exhibition Galleries of the Imperial Institute.

African Mahoganies.—In his *Report on the Afforestation of Togo*, 1912, Unwin refers to experimental plantings of two species of Khaya and of the Rhodesian "mahogany" (*Afzelia africana*). The plantations have been formed by transplanting or by planting at stake, and are to be grown as high forest with a rotation of eighty years. The largest area is occupied with *Khaya senegalensis*, over 2,000 acres in different parts of the country having been planted with this species. The tree has been found to grow somewhat slowly and to be very susceptible to the effects of stagnant water or bad drainage, becoming under such circumstances stag-headed and more liable to borer attack. A light, well-drained soil appears to be most favourable to the tree. This species is found to grow best in mixture with other trees, sasswood (*Erythrophlœum guineense*) and teak being tried with success.

Eighty-four acres have been planted up with *Khaya Klainii*, the timber of which is very similar to that of *K. Punchii* and *K. grandis*. The growth of this tree is considerably faster than that of *K. senegalensis*, but it would seem to be the most exacting of the mahoganies with regard to soil fertility. Practically the whole area planted is in mixture with teak and sasswood. Rhodesian mahogany is found in the dry zone and deciduous forest of Togo. It has been used for bridge and house building in the German colony, and in Southern Nigeria the Public Works Department has successfully employed this wood. The total area planted is 174 acres, carrying a mixture of Afzelia, iroko (*Chlorophora excelsa*) and sasswood, or other species. The tree does not appear to be exacting as to soil conditions, but it is of slow growth, and of "stumpy" habit when young, six-year-old plants being only 32 in. high, with a girth of 18 in.

Iroko or Odoum.—The German plantations of this tree

(*Chlorophora excelsa*) in Togo are described by Unwin in the report referred to above. The best results have been obtained from seeds sown at stake, and it would appear that the plant is exacting as to soil and intolerant of shade. The growth is good, a height of 24 ft. with a girth of 28 in. being reached in three years. Both pure and mixed plantations have been made, but a mixture of teak with iroko is better than the iroko alone. The plantations are to be grown as high forest, with a rotation of eighty years.

Sasswood.—This wood (*Erythrophlœum guineense*) has been largely used in Togo for bridge construction, for which purpose it has been found to be very durable, and immune from attacks of white ants; it is also said to be without an equal for pile-work. The German plantations of this species are referred to by Unwin in the report already mentioned. Over 580 acres have been planted, chiefly at Haho-Baloë, and mostly on poor soil. Sowing at stake has been more successful than transplanting, though somewhat slower growth results, the average being 2 ft. in the first year, but with a faster rate in subsequent years. Mixed plantations have been found to be preferable to pure growths, and teak and mahogany have been used for this purpose.

Tanning Materials

Divi-divi.—According to the annual report of the work done during 1911–12 at the Experimental Gardens at Amani, German East Africa, divi-divi (*Cæsalpinia coriaria*) trees planted at the end of 1908 have in some cases blossomed and borne a few fruits, which have not ripened (*Der Pflanzer*, 1912, **8**, 530). The trees, on the whole, are considered to have developed well. The trees at Rabaoul Gardens are doing well, but the younger ones have suffered from the effects of drought (*Deut. Kolonialblatt*, 1912, **23**, 92). A sample of pods from this station has been reported on as satisfactory by the Leather Institute at Freiberg.

Mangrove.—In Portuguese East Africa both white and red mangrove trees exist in great quantities along the shores of the bays and inlets. The red variety has been exploited for several years, and is shipped to the United States, where there is an extensive and growing market for this tanning material (*Ind. Tr. Journ.* 1912, **26**, 122).

Prior to 1908 the district of Lourenço Marques was the centre of this industry, but in that year an order was put into effect which prohibited the collection of mangrove bark for industrial purposes for a period of ten years. As a consequence, the territory of the Mozambique Company has now become the centre of the industry. The extent of the forests here is unknown, but in 1910 bark was exported to

the value of £19,000. The bark is stripped from the trees and collected into piles on the shore by the natives at a daily wage of 5*d.* to 1*s.*, and is ultimately shipped by coasting vessels to the large sea-ports.

The Philippine Islands also contain vast forests of mangroves, 500,000 acres in extent. The commonest varieties found are *Rhizophora mucronata* and *R. conjugata*, the barks of which contain 28 per cent. of tannin and *Bruguiera gymnorrhiza* and *B. eriopetala*, both with 32 per cent. of tannin in their barks. These barks could be used for the manufacture of extract, which would find a market in the United States, where it would probably compete successfully with that from Borneo, since it would be admitted duty free (*Bull. Écon. Indo-Chine*, 1912, **15**, 770).

In Malaya at the present time only a small quantity of mangrove bark is used for tanning purposes, and that chiefly by the Chinese (*Agric. Bull. F.M.S.*, 1912, **1**, 177). The barks of *Ceriops candolleana*, *Rhizophora mucronata*, and *R. conjugata*, were found to contain 42·6 per cent., 29·1 per cent., and 10·4 per cent. of tannin respectively, and there appears no reason why these materials should not be profitably used for the manufacture of tanning extract, as is done in Borneo, especially as large quantities of bark are obtained as a by-product of the firewood industry.

ECONOMIC MINERALS

Alunite.—"Alunite," by B. S. Butler and H. S. Gale (*Bulletin* No. 511, 1912, *U.S. Geol. Surv.*), gives an account of a newly-discovered deposit of alunite near Marysvale, Utah, which is now being developed, and promises to become a source of potash. Alunite closely resembles potash alum in its chemical composition, but contains a relatively larger proportion of alumina. It is insoluble, but is readily converted into either the soluble potash alum or potassium sulphate. The Marysvale alunite contains about 10 per cent. of potash (K_2O).

The deposit occurs in a large banded vein cutting through the andesites (volcanic rocks) which form the greater part of the Tushar Range. These volcanic rocks are post-Jurassic in age, and are probably Tertiary. On each side of the main vein smaller bands of alunite alternate with bands of silicified wall-rock. In one place the main vein is 20 ft. thick. The outcrop has been proved over a length of 3,500 ft., and assuming an average width of 10 ft., it is estimated that there will be at least 300,000 short tons of the rock for each 100 ft. of depth, so long as the deposit maintains its surface dimensions and quality.

An examination of the mineral veins of the district shows that they are for the most part fissure veins of the

quartz-carbonate type. Many of them contain notable amounts of adularia (a potash felspar), together with smaller amounts of other minerals, including fluorite and metallic sulphides, sulpharsenides, sulphantimonides, and selenides. Alunite is exceptionally an important constituent, and in the particular case dealt with it is the chief constituent. Less important occurrences of alunite are met with in other parts of the United States, notably in Colorado and Nevada. Among the Rosita Hills of Colorado alunite occurs as a granite-like rock associated with quartz, but these rocks contain only about 2·4 per cent. of potash.

Outside the United States, perhaps the most important occurrences are those of Bullah Delah, in New South Wales, and Tolfa, near Civita Vecchia, in Italy.

At Bullah Delah, N.S.W., there is a narrow range of hills three miles long, with a maximum altitude of 900 ft., which for a mile or more of its length is composed almost entirely of the mineral alunite; there are several varieties of the mineral at this locality, the purest being very compact and light pink in colour, and containing 9·5 per cent. of potash. The Bullah Delah deposit has been worked for many years as a source of alum. (See "Alunite or Alumstone," *Min. Res. N.S.W.*, by E. F. Pittman, 1901, p. 415.)

The Tolfa deposits in Italy are vein deposits, and have been worked for four centuries. (See "La métallogénie de l'Italie," by L. de Launay; *Compt. Rend.*, 10*th Internat. Geol. Cong.*, *Mexico*, 1906, Pt. 1, p. 679.)

Copper Ore.—*Mem.* No. 21, 1912, *Geol. Surv. Branch, Dept. of Mines, Canada*, gives an account of "The Geology and Ore Deposits of Phœnix Boundary District, British Columbia," by O. E. Le Roy.

Phœnix is the most important copper camp in Canada. Up to July 1, 1910, the mines have produced and shipped over 7,000,000 tons of ore. The geological formations of the locality include the Knob Hill group, consisting of a complex of various rocks of igneous origin and a minor development of sediments including limestone; the Knob Hill group is succeeded by the Brooklyn formation, which consists of crystalline limestones, tuffs, and argillites. These two formations are of Palæozoic and possibly of Carboniferous age. There are a few small intrusions of syenite and syenite porphyry, which are supposed to be connected with the more extensive granodiorite intrusions, of possibly Jurassic age, widely developed elsewhere in the district.

The ore-bodies occur in a mineralised zone which represents a portion of the Brooklyn limestone replaced by epidote and garnet. They range in size from lenses about 100 ft. long and 20 ft. thick to extensive masses like

the main ore-body of the Knob Hill-Ironside mine, which is about 2,500 ft. long, 900 ft. wide, and has a maximum thickness of 125 ft.

The ore is uniform throughout. It consists of finely disseminated chalcopyrite, with pyrite and hæmatite, in a gangue composed chiefly of epidote, garnet, quartz, calcite, and chlorite. Magnetite occurs in distinct masses, both in and along the borders of the main ore-bodies. The chalcopyrite carries all the copper, gold, and silver values, the average ore containing from 1·2 to 1·6 per cent. of copper, and gold and silver to the value of about $1 per ton. The ore-bodies are supposed to have been formed by metasomatic replacement of the limestone under the influence of solutions arising from the granodiorite intrusions.

Diatomite.—In "Diatomaceous Earth and its Occurrence in Victoria" (*Bull.* No. 26, 1912, *Geol. Surv., Victoria*), D. J. Mahony gives a list of the localities in Victoria where diatomite is known to occur, and describes the deposits. The better qualities of diatomite are almost always associated with basalt belonging to the Newer Volcanic series, which is probably all of Pliocene age or younger. The deposits sometimes rest on the surface of older sedimentary rocks, and are covered with basalt; they may be interbedded with basalt flows; or they may fill depressions in the surface of the basalt.

The chief deposits are those at Lillicur, where diatomite has been worked for some years: practically the whole of the diatomite mined in Victoria comes from this locality. One deposit at Lillicur completely fills a basin-shaped hollow in the basalt, the maximum depth being 17½ ft. It covers an area of over 4½ acres. This hollow is estimated to carry over 60,000 tons of diatomite. The basalt in which it occurs is highly vesicular. The deposit is horizontally stratified, and of snowy whiteness. Occasionally, cracks filled with clay or pale yellow opal are found in the beds. In another deposit mining operations are being carried on by means of shallow shafts, from which drives and cross-cuts are put out into the deposit, which is capped by basalt.

The output of diatomite from the Lillicur deposits during recent years has been as follows: 800 tons, valued at £2,400, in 1909; 500 tons, valued at £2,000, in 1910; and 400 tons, valued at £1,600, during 1911. The total quantity that has been mined in Victoria amounts to about 3,900 tons, valued at £15,900.

Gold.—*Mem.* No. 12, 1912, *Geol. Surv., Victoria*, is a "List of Nuggets found in Victoria." Nearly all the Victorian nuggets have been obtained from the area between Ballarat on the south, Wedderburn on the north, Tarnagulla on the east, and Ararat on the west.

The number of nuggets in the list is 1,327. At the head of the list is "The Welcome Stranger Nugget," with a net weight of 2,284 oz. 16 dwt. 22 gr. There are 11 others with a weight exceeding 1,000 oz. Nos. 13 to 48 range in weight from 1,000 oz. to 500 oz.; Nos. 49 to 396 range from 500 oz. to 100 oz.; and Nos. 397 to 1,327 range between 100 oz. and 20 oz.

In a preface to this list, E. J. Dunn, the late Director of the Survey, deals with the origin of nuggets.

Nuggets frequently contain quartz, and are sometimes embedded in that mineral. Mr. Dunn states that where the gold and associated quartz are in contact the quartz is always angular; it is in just the same condition in which it occurs in the reefs, and is not rounded and water-worn as it would be if the gold had grown round it in alluvial deposits. Another mineral frequently associated with the nuggets is limonite, which has resulted from the oxidation of iron pyrites that existed originally in the lode. The nuggets are also frequently stained with ferruginous clay and oxide of manganese. Their surfaces invariably show much scratching and rounding, a fact inconsistent with the view that they have grown in the gravels. Mr. Dunn concludes that, though there is ample proof of the presence of gold in drift waters, there is no evidence that accretion of gold occurs so as to enlarge the size of the nuggets in the drifts.

Mica.—"Mica, its Occurrence, Exploitation, and Uses," by H. S. de Schmid (*Mines Branch, Dept. of Mines, Canada*, 1912), is a second edition, re-written and greatly enlarged, of a monograph on Canadian mica. The first edition, by F. Cirkel, was issued in 1905, and contained 148 pages. The second edition has grown to 411 pages, and is profusely illustrated with maps and plates. Part I. gives a list of the principal mica deposits which have so far been exploited, together with an account of the work done at the various mines. Part II. deals with the mineralogy of mica, its modes of occurrence, the minerals associated with it, its uses and preparation for the market. Part III. gives an abstract of mining laws.

The demand for mica has suffered much fluctuation during recent years, reaching its minimum in 1907–8. This has led to a severe restriction of mining operations, and large numbers of properties are still closed down, the owners not considering the present market profitable enough to warrant re-opening.

The operations of mica-winning in Canada are those of surface quarrying rather than of true mining. Many operators extract the mica in sight at the surface and then abandon the place without further development. In some cases, however, the deposits have been followed by means

of shafts and drifts to depths of 100 ft. or more, and the results obtained have shown that the mica continues in depth, though the pockety nature of the occurrences will always prove a serious obstacle in exploitation.

Trona.—The *Rec. Geol. Surv., India* (1912, **41**, Part IV.), gives an account of the geology of the Lonar Lake by T. H. D. La Touche, with a note on the Lonar soda deposit by W. A. K. Christie. The Lonar Lake is in the Buldana District of Berar, in the Central Provinces of India. It lies in an almost circular hollow in the basaltic lavas of the district, and is surrounded, except on the north and north-east, by a raised rim of basalt. The hollow is 1¼ miles in diameter, measured from crest to crest of the rim, and about 300 ft. deep. The lake has no outlet, and its waters are charged with alkali salts. During the visit of Messrs. La Touche and Christie in March 1910, the lake was almost at its lowest, and was in no place more than 2 ft. deep.

Crude soda has been obtained from the lake for centuries. At the present time the method adopted to obtain the salts is as follows: When the lake water has receded by evaporation, a whitish incrustation known as "bhuski" is left on the shores. This contains algæ and other organic impurity, and is at present unsaleable. Wooden stakes are fixed in the bottom of the lake at intervals determined by experience; when the water has evaporated so far as to leave the outermost stake on dry land, the first layer of crystals, known as "papri," is collected by hand from the bottom of the lake. This generally takes place about May, when the lake is about 6 in. deep. When the brine has retreated as far as the next stake, "khuppal" is similarly collected, and "dulla" after a further retrogression. The deposits formed after that are called "nimak dulla" or "dulla nimak." The following analyses, taken from a report by F. J. Plymen (*Ind. Trade Journ.*, 1909, **14**, 229), show the percentage composition of the various products:

		Dulla.	Khuppal.	Dulla nimak.	Nimak dulla.	Papri.	Bhuski.
Carbon dioxide	CO_2 as carbonate .	19·47	10·00	13·72	4·84	9·62	13·58
,, ,,	CO_2 as bicarbonate	17·38	9·52	13·72	4·49	9·02	14·42
Chlorine	Cl	trace	22·73	14·72	43·25	25·48	2·03
Soda	Na_2O	33·65	35·17	34·42	44·54	33·36	26·15
Potash	K_2O	7·14	6·88	9·95	4·28	10·29	5·07
Silica	SiO_2	0·17	0·40	0·33	0·26	0·05	0·30
Ferric oxide and alumina	$Fe_2O_3 + Al_2O_3$.	0·46	1·21	0·64	0·65	1·47	4·58
Lime	CaO	0·13	0·24	0·24	0·16	0·26	1·35
Magnesia	MgO	0·09	0·22	0·21	0·22	0·40	0·39
Sulphur trioxide	SO_3	none	0·70	0·10	0·08	0·87	0·21
Water and organic matter .	. . .	20·90	16·03	15·30	6·46	14·71	24·46
Insoluble residue	. . . .	2·07	5·49	2·57	2·21	5·01	20·83

The analyses show that the salts deposited by the lake waters are partly sodium chloride and partly trona (Na_2CO_3, $NaHCO_3$ $2H_2O$).

These salts appear to owe their origin to slow concentration from the waters of the streams entering the lake. The unweathered trap rock of the neighbourhood contains all the necessary ingredients; and the water of the spring feeding the main stream contained the equivalent of 0·30 gram of sodium carbonate per litre. It is considered probable, however, that the chlorides are derived to some extent from the sea, and are carried in the strong westerly winds that blow steadily from the coast towards Lonar.

NOTICES OF RECENT LITERATURE

New Books

The Empire of India. By Sir Bampfylde Fuller K.C.S.I., C.I.E. Pp. xi + 394, with coloured map and full-page plate illustrations. Demy 8vo. (London: Sir Isaac Pitman & Sons, 1913.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 11*d.*, abroad 8*s.* 3*d.*

The number of books published at the present time concerning the British possessions and dependencies overseas indicates the public interest that is taken in the various countries that comprise the British Empire. Not the least important of these works are the volumes comprising the "All Red" Series, of which this is the sixth instalment.

Sir B. Fuller's long service as an Indian official, and especially his experience as Lieutenant-Governor of Eastern Bengal and Assam, under Lord Curzon's administration, brought him into direct contact with the various peoples of India, and this eminently qualifies him to discuss the numerous problems and difficulties of Indian administration.

The book gives in a concise and readable form an account of India as it exists at the present day, and describes the country, the people, the Government, and India's future prospects. The last two sections are perhaps the most interesting in the book, and contain much that is of topical interest, such subjects as education, taxation, the influence of British rule, and the political aspirations of the Indian reformers, being fully dealt with. With reference to the last-named subject, the author states, "British authority must be maintained, not only in the interests of British manufacturers and officials, but in the interests of India's peace and progress. And it has been an accepted function of British rule to foster progress, to encourage the adoption of Western ideas, and to provide such opportunities as it can for their exercise. Rooted in these ideas

are aspirations for power in politics, and these are naturally entertained by Indians who have sat at the feet of Western teachers. To meet them without risking the stability of the Government is a problem of ever-increasing complexity."

CAMP AND TRAMP IN AFRICAN WILDS. By E. Torday. Pp. 316, 8vo. (London: Seeley, Service & Co., Ltd., 1913.) Price 16*s.* net; post free, United Kingdom 16*s.* 5*d.*, abroad 16*s.* 10*d.*

This is a narrative of experiences in the Congo during the period 1900 to 1907, the whole of which time the author spent in that region, with the exception of a short interval of a few months.

The author confines his attention to giving a straightforward account of his own tours, and of the habits and characteristics of the various native tribes with which he came into contact. He has a great many observations to put on record, and these are described in a thoroughly interesting way, so that the book makes enjoyable reading. It is well illustrated by reproductions from photographs of typical natives and native scenes, and contains a good map of the Congo, in which the routes followed are shown.

QUEBEC: THE LAURENTIAN PROVINCE. By Beckles Willson. Pp. xii + 272, 8vo. (London: Constable & Co., Ltd., 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 10*d.*, abroad 11*s.* 3*d.*

Though Quebec, and especially its French-speaking population, receives a considerable amount of attention in ephemeral political literature relating to Canada, there is a tendency in this country to regard the newer provinces in the west and far west as perhaps the most interesting parts of the Dominion, possibly because the material resources of these areas are so constantly and vigorously impressed on the attention of the mother-country.

A tour in the Dominion is certainly the best method of correcting such an impression, but for the millions of Englishmen who are unable to visit even the nearest of the Overseas Dominions, Mr. Willson's various books dealing with the eastern provinces of Canada will do much to enable them to view the various parts of the Dominion in more correct perspective. Quebec, as Mr. Willson describes it, is a prosperous province in which industry and agriculture are vigorously prosecuted, but in which the banalities that so often accompany rapid material success in new countries have been largely avoided by the good sense of its people.

A large part of the book is devoted to descriptions of the two chief cities, Quebec and Montreal, and of typical parts of the province. Room is, however, also found for chapters on the influence of the Roman Catholic Church on the life

of the province, on the use of the French language, the relations of the French Canadians to their compatriots, and on the development of literature and art in the province.

The volume is fully illustrated by reproductions from photographs, and contains a useful map of the province.

GREATER ROME AND GREATER BRITAIN. By Sir C. P. Lucas, K.C.B., K.C.M.G. Pp. 184, 8vo. (Oxford: Clarendon Press, 1912.) Price 3*s.* 6*d.* net; post free, United Kingdom 3*s.* 10*d.*, abroad 4*s.*

A book on the philosophy of Empire, in which the Roman and the British systems are contrasted—or, rather, seen for the most part under antithetical aspects—comes as a welcome contribution from the pen of Sir Charles Lucas.

In their dominant characteristics, the Roman Empire was a military Empire; the British Empire is a naval Empire—and much else besides. The Roman Empire was one, and practically undivided: Roman citizenship was a very real thing. The marvel is, not that the Empire fell—for want of competition, perhaps—but that it endured beyond the centuries of its unrivalled power. The British Empire—divided, yet united by sea power—embraces, like the Roman, a sphere of rule; and also, within its overseas development, a sphere of settlement. The most marked antithesis between the British and Roman systems is presented in Austral Britain; the only analogy, perhaps, in British India. "A nearer approach to British colonization," the author states (p. 22), "is to be found in the history of Greece than in that of Rome." But, in fact, there is "no parallel to it in the history of the world." That is what makes the subject so interesting, and so deserving of special study.

In the internal relations of the British Empire, the analogy of the family—Mother-Country and Daughter States, or Self-Governing Dominions—is faithfully followed; but the author somewhat transgresses the sanction of geographical science by insisting too rigidly on the Empire being really two Empires in one: the sphere of rule (the Dependencies) and the sphere of settlement (Self-Governing Dominions). India is, indeed, in the strictest sense, a Dependency of the Crown—and never can become a true colony of settlement; but all else, outside the temperate regions, may be included under appanages of Empire, or colonies of exploitation, in which British rule is mainly conspicuous.

The bulk of the book is filled with a searching, if somewhat cursory, analysis of the foundations of Empire under the broad philosophical categories of Space, Youth, Science; the Individual, the Company, and the State; Class, Colour, and Race; the Natural and the Artificial. All this is delightful reading. Though we cannot quite follow the author in his

empirical treatment of "The two Empires," we are wholly with him in the concluding chapter on "The British Instinct and the Law of National Life"—the British instinct standing for "the instinct of wise opportunism: the one and only safe guide to sound relations between the Self-Governing Dominions and the Mother-Country."

We are grateful to Sir Charles Lucas for giving us this aftermath of his scholarly researches in the historical geography of the British Empire.

SIAM AND ITS PRODUCTIONS, ARTS, AND MANUFACTURES. By Colonel G. E. Gerini. Pp. lxiv+339, 8vo. (Hertford: Austin & Sons, Ltd., 1912.)

This is an English edition, revised and brought up to date, of the handbook prepared for the Siam Section of the Turin Exhibition held in 1911. It gives a great deal of information regarding Siam, its people, arts, productions, and manufactures, and should serve the purpose of making English business men better acquainted with the resources of this interesting Far Eastern country.

WELTWIRTSCHAFTLICHES ARCHIV. Zeitschrift für Allgemeine und Spezielle Weltwirtschaftslehre, 1 Band, Heft 1. Pp. 248+92+35, Med. 8vo. (Jena: Gustav Fischer, 1913.) Price 10*s.*; post free, United Kingdom 10*s.* 4*d.*, abroad 10*s.* 6*d.*

This new journal is a quarterly review of economics, edited by Dr. Bernhard Harms, of Kiel University, and is an example of the literature produced by the school of "world economists" that has arisen in Germany in the last few years, with its centre in Kiel, where an Institute of Sea Transport and World Economics has been founded in connection with the University.

Each number of this review will consist of three parts, viz. articles by experts, reviews of literature, and a chronicle of recent events of interest to economists and men of business. The special articles in this number include several likely to be of great interest in this country. Dr. Harms discusses world economics and the study of this new science. Dr. Thiess, of Dantzig, deals with the railway gauges of the world and the desirability of a uniform gauge. Dr. Liefmann, of Freiburg, gives an interesting account of the international organisation of the Frankfort business in metals. Other useful articles are on sea insurance, by Herr Fitger, of Bremen, and on the international effects of the new Italian insurance monopoly law, by Dr. Rocca, of Rome.

The notices of recent literature form perhaps the most remarkable portion of this new review. This part appears to aim at giving at least a short summary of the contents of each publication on economics issued during the preceding quarter in any part of the world. The more important

books are reviewed in detail by well-known authorities on the subjects of which they treat, whilst the contents of less important works, or of publications only remotely connected with economics, are summarised.

The third part is a chronicle of recent information on various branches of economics, *e.g.* sea-transport, railways, posts and telegraphs, telephones, international trade and trade statistics, international finance, emigration, banking statistics, etc.

The great majority of the contributors are, of course, German, but the co-operation of economists and experts in this country, France, the United States, and elsewhere, has been secured, and when the publication has got thoroughly started it will no doubt present each quarter a most interesting account of economic developments in all parts of the world. It should be of special value in this country, where, if world economics has not been made the subject of academic study, its practical side is at least well understood.

VOORDRACHTEN OVER KOLONIALE ONDERWERPEN. Gehouden ter Gelegenheid van de Koloniale Landbouwtentoonstelling te Deventer. Met 54 Illustraties naar Foto's. Pp. 201, Roy. 8vo. (Deventer: Æ. E. Kluwer, 1913.) Price 3·50 florins (5*s.* 10*d.*); post free, United Kingdom 6*s.* 2*d.*, abroad 6*s.* 5*d.*

In May 1912, a small but interesting exhibition of raw materials from the Dutch Colonies was held at Deventer in Holland. During the exhibition a series of lectures was delivered dealing with various aspects of tropical agriculture, and these lectures have now been reproduced in this volume. There are thirteen lectures in all, eight in Dutch, one in English, three in French, and one in German, so that a perusal of the volume calls for a certain amount of linguistic ability. The subjects are well chosen, with a view to giving a general idea of some of the principal problems of tropical agriculture at the present time, and they include the following: Irrigation in Java, the Improvement of Java Tea, Technique of the Java Sugar Industry, Cultivation of Cinchona and the Manufacture of Quinine, Rubber, Exploitation of Rubber Trees in Africa, Agricultural Productions in French Tropical Colonies, Preparation of Cocoa, and the Chemical Composition of Tropical Soils. Most of the lectures are illustrated by reproductions from photographs.

LES TEXTILES VÉGÉTAUX. By J. Beauverie, with preface by H. Lecomte. Pp. xiii + 730, Roy. 8vo. (Paris: Gauthier-Villars, 1913). Price 18 fr. (14*s.* 6*d.*); post free, United Kingdom 15*s.*, abroad 15*s.* 9*d.*

The information hitherto published on the cultivation, preparation, and utilisation of vegetable fibres is scattered over so wide a range of literature that the compilation of a

general treatise on the subject was sorely needed. The present work will therefore be welcomed as supplying this want, and will be of much service to those engaged in cultivating fibres or manufacturing textiles, as well as to merchants and others interested in these materials.

In the first part of the book, the anatomical origin of the various fibres is discussed, their physical and chemical characters are described, the general principles of the retting process are explained, and a classification is provided.

In the second part, of which nearly one-third is devoted to cotton, the fibres are dealt with individually in the order usually adopted in systematic botany. In each case, the plant is described, an outline of the methods of cultivation is given, and reference is made to the diseases and pests by which it is liable to be attacked. Details are given of the processes of extraction and preparation, statistics are furnished to indicate the relative importance of the product in the various parts of the world, and recent prices are recorded.

The work is well illustrated and contains a good index, and a useful, classified bibliography.

The Testing of Wood Pulp. A Practical Handbook for the Pulp and Paper Trades. By Messrs. Sindall and Bacon. Pp. 148, Demy 8vo. (London: Marchant Singer & Co., 1912.) Price 5*s.* net; post free, United Kingdom 5*s.* 3*d.*, abroad 5*s.* 4*d.*

During the last forty years or so, the utilisation of wood pulp for the manufacture of paper has assumed enormous proportions both in the United Kingdom and on the Continent. It is of the utmost importance to papermakers that the consignments of wood pulp which they receive should be submitted to examination in order to ensure that they do not contain an excess of moisture and that the material is of the quality required for their purposes. The need of a simple handbook on the methods of testing wood pulp has led the authors to prepare the present treatise, which embodies the results of the principal workers in this sphere and describes the methods now employed in various countries.

The book is divided into two sections, the first dealing with the withdrawal of representative samples from the bulk and the estimation of moisture in them, and the second relating to the mode of ascertaining the bleaching qualities of the pulp. In an appendix, a short account is given of the chemistry of the bleaching process and the preparation and behaviour of bleaching liquors. The subject-matter is well arranged, and numerous illustrations and useful tables are provided. The book will doubtless be very welcome to paper-mill chemists and will also be of service to manufacturers of wood pulp.

Researches on Cellulose.—III (1905–1910). By C. F. Cross and E. J. Bevan. Pp. x + 173, 8vo. (London: Longmans, Green & Co., 1912.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.*

In two earlier volumes the authors have dealt with the work on cellulose accomplished during 1895–1900 and 1900–1905 respectively. The present volume gives an account of the investigations carried out during 1905–1910. The researches are divided into several classes, including those dealing with normal cellulose and its constitution, the cellulose esters, the lignocelluloses, and technical developments in the various industries connected with cellulose, such as the manufacture of textiles, paper, artificial silk, and celluloid. Summaries of the various researches are given and discussed. These memoirs serve a useful purpose in providing a ready means of obtaining knowledge of recent progress in this branch of chemistry, and are consequently of considerable value to those interested in the subject.

Fatty Foods: their Practical Examination. By E. R. Bolton and Cecil Revis. Pp. x + 371, 8vo. (London: J. & A. Churchill, 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 11*d.*, abroad 11*s.* 2*d.*

This work is primarily intended for the use of chemists engaged in the analysis and investigation of oils and fats. The first part of the book is devoted to the description of analytical methods, only the more modern and reliable methods being included, while the consideration of a number of typical cases of adulteration and of problems for investigation is a particularly valuable feature. Following this are descriptions of all the common and of some of the less common edible oils and fats. It is, of course, impossible to give very full details in a work of this scope, but a large amount of useful information is given; the illustrations of oil-seeds included in this section are, however, very poor, and in some cases misleading (*e.g.* those of ground nuts and shea kernels). In the latter part of the book the examination of cocoa, chocolate, feeding stuffs, and milk is dealt with, and in connection with the examination of cocoa a number of photomicrographs of starches are given; these are too small to be of much use, and are also not very well reproduced.

On the whole the work is clear, devoid of unnecessary detail, and well arranged, and will form a valuable reference book for the analyst and all interested in edible oils and fats.

Beurres et Graisses Animales. By A. Bruno. Pp. 300, Crown 8vo. (Paris et Liége: Ch. Béranger, 1912.) Price 6 fr. (5*s.*); post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

This volume deals chiefly with the methods of examination of butter, margarine, lard, etc., and is very similar in

scope and arrangement to a previous book of the same series dealing with vegetable fats, and already reviewed in this BULLETIN (1912, **10**, 523). It will form a valuable addition to the library of the analyst, and will also be of interest to all who are in any way connected with the trade in these important articles of food.

INJURIOUS INSECTS: HOW TO RECOGNISE AND CONTROL THEM. By Walter C. O'Kane. Pp. 414. (New York: The Macmillan Company, 1912.) Price 8*s.* 6*d.* net; post free, United Kingdom 8*s.* 11*d.*, abroad 9*s.* 5*d.*

This book, while primarily concerned with the more important insect pests affecting the crops of the United States, should prove very useful to students of economic entomology in other countries. The subject is treated in a semi-popular style in so far as the term indicates an absence of abundant technical nomenclature, but the work is free from that annoying inutility which not infrequently accompanies the popular treatment of this branch of agricultural science. The book is divided into three parts. Part I. gives an interesting account of the structure, habits, and classification of insects, while Part II. is concerned with the practical methods adopted for the control of insect pests, and affords the usual information in regard to insecticides and the apparatus employed in their application. Part III. forms the bulk of the book, and consists of a systematic account of a large number of insect pests, an important feature being the fine series of photographs (some 600 are found in the book) which illustrates the text. The pests are considered in three groups, viz. (1) insects attacking garden and field crops; (2) those affecting orchard and small fruits; and (3) household pests infesting stored products and domestic animals. Identification of a pest is further facilitated by a practical sub-grouping according to the actual place in which the pest is found at work, *e.g.* in the soil, in the tree trunk, in the leaf and fruit. There is a very full index, occupying nearly twenty-four pages. A handbook of this character should be strongly bound, and weigh less than 2¼ lb.

INSECTICIDES, FUNGICIDES, AND WEEDKILLERS. A Practical Manual on the Diseases of Plants and their Remedies, for the use of Manufacturing Chemists, Agriculturists, Arboriculturists, and Horticulturists. By E. Bourcart, D.Sc. Translated from the French, revised and adapted to British standards and practice by Donald Grant. Pp. xxxv + 431, Demy 8vo. (London: Scott, Greenwood & Son, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 11*d.*, abroad 13*s.* 4*d.*

This work contains an account of the various remedies which have been employed for the treatment and preven-

tion of plant diseases. In an introductory chapter, the various causes of disease are briefly reviewed, and general curative and prophylactic measures are discussed. In the subsequent chapters, the various agents used as insecticides, fungicides, or weedkillers are considered in turn, the inorganic substances being dealt with first.

Each chemical agent is made the subject of a separate section, and an account is given of its mode of preparation, its properties, and its application in the prevention or cure of plant diseases. Numerous recipes are provided for the preparation of sprays, washes, weedkillers, etc., and instructions are given as to the manner in which they should be applied. The paragraphs on the preparation of the various chemicals do not appear to add to the value of the book, and might well be dispensed with, as the information afforded is not likely to be of any utility to the various classes of readers mentioned in the title. In most cases the particulars supplied are quite inadequate, and in many instances misleading.

The scope of the work is almost entirely restricted to plants of the temperate zone, and its value is thereby greatly limited. If the diseases of tropical economic plants, such as cocoa, coffee, cotton, rubber, and tobacco, were included, the book would be very useful to planters in the Colonies.

A glossary is appended of the principal diseases of plants and of the parasites or pests by which they are occasioned. An outline of the life-history and habits of each pest is furnished in order to afford an indication of the periods of its existence in which it is most vulnerable, and therefore most easily checked. An index, numerous tables, and several illustrations are provided.

PRACTICAL AGRICULTURAL CHEMISTRY. By S. J. M. Auld, D.Sc., Ph.D., and D. R. Edwardes-Ker, B.A., B.Sc. Pp. xxiv + 243, Crown 8vo. (London: John Murray, 1913.) Price 5*s*. net; post free, United Kingdom 5*s*. 4*d*., abroad 5*s*. 6*d*.

The scope of this practical handbook, which is intended for agricultural students, is wide, embracing the chemical examination of foods, water, soils, resins, alkaloids, glucosides, soaps, tanning materials, essential oils, fats, manures, fibrous wastes, oil-cakes, cereals, roots, and green fodders. But in spite of the mass of information in the book, it is clearly written, and the experiments are lucidly described. Students should be grateful for having been spared the task of studying numerous voluminous treatises in order to gain what this volume so tersely presents, an introductory knowledge of that very wide subject—agricultural chemistry.

The book is divided into six sections, the first of which

deals with the ultimate and proximate constituents of plants and their determination, including experiments to demonstrate cyanogenesis and photo-synthesis; section ii. is devoted to the chemical and physical properties and the chemical and mechanical analysis of soil; section iii. treats of the examination of manures and fertilisers; whilst sections iv. and v. deal with feeding stuffs and dairy products respectively. The last section of the book describes the examination of waters and soap.

In each branch of the subject many experiments are described purely to demonstrate to the student a point at issue, but at the same time the book does not neglect processes which are accepted as standard methods by analysts.

There are thirty-one illustrations of apparatus in the book, partly diagrams and partly reproductions from photographs. They should prove of real value to the student in practice, but the same cannot be said of the photomicrographs of starch granules in Fig. 9.

The Mineralogy of the Rarer Metals. By E. Cahen and W. O. Wootton, with a foreword by F. W. Harbord. Pp. xxviii + 211, Foolscap 8vo. (London: C. Griffin & Co., Ltd., 1912.) Price 6*s.* net; post free, United Kingdom 6*s.* 2*d.*; abroad 6*s.* 3*d.*

This is a pocket-book, dealing with the minerals which contain what are styled the rarer metals. It is intended for use by prospectors. The metals are arranged alphabetically. In each case are given the properties, preparation, industrial application, and commercial value; and this is followed by an account of the minerals containing the metal. Only the simpler characters of the minerals are given. There is a small section on methods of analysis, which might with great advantage have been made fuller.

Much care has evidently been bestowed on the work of compilation, but the results, especially as regards commercial information, leave much to be desired. The term "commercial ores," which is used throughout the book, is redundant, and under this head much misleading information is given. Thus on p. 23 it is stated that monazite, cerite, allanite, and gadolinite are "commercial ores" of cerium. Gadolinite contains little or no cerium, and is certainly not a cerium ore. The statement also implies that cerite and allanite are in demand as a source of cerium, which is not the case. Monazite is in demand not as a source of cerium, but of thorium, and is paid for on the basis of its thorium contents only.

In addition, it is asserted that "monazite 95 per cent. pure containing 5 per cent. ThO_2 is worth £54 per ton. Monazite 95 per cent. pure containing 3 per cent. ThO_2 is worth £25 per ton," which is not the case at the present

time. The values of rare minerals are much too uncertain to be worth quoting in a publication such as this.

On p. 159 zircon is mentioned as the "commercial ore" of zirconium. Nothing is said under baddeleyite of the importance of this mineral as a source of zirconia, and the 106 tons of "zircon" stated on p. 159 to have been exported from Brazil was probably baddeleyite, and not zircon (see this BULLETIN, p. 147).

It seems rather singular that the authors should raise such minerals as "auerlite" and "naëgite" to the dignity of distinct species, whilst they regard ilmenorutile and strüverite as varieties of rutile. It is stated, moreover, that strüverite is orthorhombic (p. 116).

Among various other matters which call for criticism, it should be mentioned that there is an unnecessary amount of blank paper in the book; and the section dealing with the geographical distribution of rare minerals is very incomplete.

The book is handy in size, well printed, and daintily bound, but has no illustrations.

SOUTH AFRICAN GEOLOGY. By E. H. L. Schwarz. Pp. vi + 200, Crown 8vo. (London: Blackie & Son, Ltd., 1912.) Price 3*s*. 6*d*. net; post free, United Kingdom 3*s*. 9*d*., abroad 3*s*. 11*d*.

This is an elementary text-book, in which the principles of geology are explained with reference to South African features.

The subject-matter is divided into four sections, viz. descriptive geology (60 pages); dynamic geology and tectonic geology (26 pages each); and stratigraphical geology (77 pages). As one might expect, the most valuable of these sections is the last, more than half of which is devoted to Cape Province, the remainder dealing chiefly with the Transvaal. A few pages are given to the stratigraphy of Natal, Damaraland, Rhodesia, and Central Africa.

The book is illustrated, some of the illustrations being fairly good, others rather crude. Cruder still, however, are many of the statements made in various parts of the book. Of these a few examples may be quoted:

"A cup of tea consists of water on the one hand, and tea, sugar, and the substance of milk on the other. If we add enough sugar the water will practically disappear, and a sticky mass will be produced quite unlike the original tea concoction. In rocks silica takes the place of water, and is called the acid; the other substances, representing the sugar, etc., are called bases, and consist of alumina, iron, lime, potash, and soda" (p. 59).

"The essential mineral [of dolerite] is one of the bases, usually iron, in the form of magnetite or titaniferous magnetite, called ilmenite, the carbon of the Kimberley diamond diggers" (p. 61).

"Sand may be consolidated into sandstone merely by pressure, or cement may be added by precipitation from water; and this cement, which may be compounds of iron, calcite, or silica, binds the grains into a firm rock, usually in such cases called quartzite" (p. 64).

"Corundum, or emery, is deposited in the same way [by pneumatolitic action], but not in the tin-wolfram series" (p. 119).

As regards the author's views on the origin of the earth, and the nature and origin of igneous intrusions, a beginner's text-book is scarcely the proper place for them. It is inadvisable to puzzle a beginner with recondite theories concerning the broad problems of geology. Before he can think profitably about these things, the student needs to have his mind furnished with sound data.

Although the book has some defects (there is no index), it has many good features, and it will be not unwelcome among students working in South Africa. When a second edition is called for, as it doubtless will be, Professor Schwarz will probably make many needful improvements and thus increase its usefulness.

Guide Scientifique du Géographe-Explorateur. By P. Crépin de Beauregard. Pp. 250. With two star maps and numerous diagrams in the text. Imp. 8vo. (Paris: Gauthier-Villars, 1912.) Price 10 fr.; post free, United Kingdom 8*s.* 4*d.*, abroad 8*s.* 8*d.*

The scope of this work is by no means so extensive as the title would imply. It is in fact a text-book of surveying for those engaged in geographical exploration and gives full directions for carrying out a provisional but systematic survey of a little-known region. In form it is an elementary text-book of the subject, but it is doubtful whether it would supply sufficient explanation and information to be intelligible to the beginner. To those, however, who possess already some knowledge of the subject it will be of the greatest interest and use, for they will find the whole subject dealt with on lines which, in many cases, differ considerably from those followed in English-speaking countries. The mathematical demonstrations, too, are frequently characterised by novelty and simplicity. The volume includes full instructions for the use of theodolites and chronometers, astronomical determinations of position and azimuth, elementary geodesy, including levelling and methods of projection, as well as practical hints for surveyors.

There are two tables, one for use in circummeridian observations for latitude and the other to be employed in the calculation of latitudes and longitudes, when the ellipsoidal form of the earth's surface is taken into consideration.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

RECENT PROGRESS IN COTTON CULTIVATION IN THE SUDAN

A SUMMARY of the cotton industry of the Sudan has already been published in this BULLETIN (1904, **2**, 120, 244), and from time to time notes on the progress which has been made since that date have appeared (1910, **8**, 292; 1911, **9**, 66, 165, 202, 409; 1912, **10**, 158). In view of the interest which is now being taken in cotton cultivation in that country, the information available as to the recent developments of the industry is summarised in the following pages.

At the present time the chief areas where cotton is cultivated in the Sudan are the Tokar district of Red Sea Province, the Kassala, and to a less extent Gedaref districts of Kassala Province, the Wad Medani, Monagil, and Singa districts of the Gezira plain, and along the Nile between Khartoum and the Atbara River, principally in Berber Province. The only locality where systematic irrigation is practised, apart from experimental areas, is in the last-mentioned district, where pumps are used; but a scheme for irrigating a considerable part of the Gezira plain has been suggested, and the British Government have guaranteed the payment of interest on a loan to be raised by the Government of the Sudan, to the extent of £3,000,000, to be applied to this and other schemes for promoting the cotton industry of the Sudan. Irrigation is to be per-

mitted in this area only between July 15 and the end of February following, when the Blue Nile is in flood, to prevent the irrigated area in Egypt from being adversely affected. With a view to ascertaining the suitability of the Gezira plain for the cultivation of cotton and other crops on a commercial scale within this period, a site has been selected at Tayiba, north of Wad Medani, where experiments will be carried out, the land being irrigated from the Blue Nile by means of pumps. An area of at least 3,000 acres is to be brought under cultivation. The experiment, which is being carried on by a syndicate on behalf of the Sudan Government, was commenced in April 1911, and will be continued over a period of four years if necessary. During the 1911–12 season cotton was grown by tenants on 250 feddans (1 feddan = 1·038 acre), whilst a further 21 feddans were used for direct experiment by the syndicate. Mitafifi cotton was grown on 15 plots of 10 feddans each, and Nubari cotton on the 10 remaining plots. The former has so far given the better result, the yield of seed-cotton per feddan varying from 459 to 1,112 lb. on the different plots, as compared with 385 to 872 lb. in the case of Nubari cotton. On the direct experimental area American and Egyptian cottons were grown, but the complete results of the experiments are not available at the time of writing. The Mitafifi cotton grown at Tayiba has been pronounced by experts to be far superior to that produced in Egypt, and just what is required by Lancashire spinners (*Rep.* No. 46, *British Cotton Growing Association*, December 1912, p. 23).

Considerable quantities of rain-grown cotton are already being exported from the Gezira, but as the rainfall varies greatly from year to year, the industry cannot be put on a stable foundation until the irrigation schemes are completed. During 1911 the rainfall was indifferent, and the exports of cotton in 1912 consequently showed a marked decrease (see p. 192).

In the Tokar district, where the land is flooded by the annual overflow of the Baraka River, 30,840 acres were planted with cotton in the 1911–12 season, and the yield reached 11,159,900 lb. of seed-cotton. In the following

season it was estimated that about 47,000 acres were under cotton, and the crop was expected to be not less than 13,000,000 lb., and possibly to reach 15,000,000 lb. Until a few years ago the cotton produced in this district was of inferior quality; it was carelessly cultivated and badly picked, and as a number of varieties were grown the resulting product was of a mixed character. Since the supervision of the industry was taken in hand by the Government only one variety—Mitafifi—has been grown throughout the district, the cultivation and picking are better performed, and the quality of the cotton has as a consequence shown a remarkable improvement. Although Mitafifi cotton has given such good results in Tokar, it is thought that a further improvement might possibly be made, and experiments have been conducted with a number of other varieties; the results obtained in 1910-11 are referred to on a subsequent page, where a description of cottons produced in the course of the experiments and examined at the Imperial Institute will also be found.

The progress of the Tokar cotton industry may be judged from the following statistics showing the yield, average price per lb., and total value of seed-cotton produced since 1904-05. The fail in price in 1910-11, as compared with 1909-10, was due to the lower prices which prevailed for Egyptian cottons as a whole, and not to deterioration in quality.

	Yield.	Average price per lb.	Total value.
	Tons.	*d.*	£
1904-5	2,098	0·80	15,575
1905-6	1,864	1·83	31,791
1906-7	2,917	2·11	57,530
1907-8	3,981	1·33	49,606
1908-9	2,343	1·62	35,450
1909-10	4,361	3·69	150,474
1910-11	6,862	2·34	149,987

In the Berber Province cotton is grown both by native and European enterprise, but so far the results have not been altogether favourable. In 1911 the crop suffered badly from boll worm and unfavourable climatic conditions, and the yields were poor. What is required in this district is the raising of a variety of cotton more suited to

the local conditions, and some system of rotation, preferably one in which a leguminous crop precedes the cotton crop.

The cotton produced in Kassala Province is mostly consumed locally or exported to Abyssinia. The land round Kassala is well suited to cotton when irrigated, whilst rain crops can be grown in the Gedaref district. It has been estimated that about 100,000 acres could be brought under cultivation if irrigation works on the River Gash were carried out, but at present the chief need is for improved transport facilities, whilst the quality of the cotton could be improved by better cultivation and selection of seed.

The quantity and value of ginned and unginned cotton exported from the whole of the Sudan during 1908 to 1911 are shown in the following table:

	1908.		1909.		1910.		1911.	
	Tons.	£	*Tons.*	£	*Tons.*	£	*Tons.*	£
Ginned cotton .	902	42,530	887	40,306	784	75,076	2,995	200,357
Unginned ,, .	2,575	40,232	1,594	17,401	6,114	155,475	2,146	41,631

In the first nine months of 1912 the total amount of ginned and unginned cotton exported was 4,163 tons, valued at £142,090. This represents a decrease of 973 tons in quantity and £99,647 in value, as compared with the corresponding period of 1911, and was chiefly due to a decrease in the amount of rain- and flood-grown cotton.

A considerable quantity of the cotton is now exported direct to the United Kingdom after being ginned in the country, 82·5 per cent. of the total crop being ginned before export in 1911, as compared with 28·8 per cent. in 1910. At present, however, the ginning facilities are quite inadequate, and much delay is occasioned as a consequence, with the result that there is a certain amount of deterioration of the cotton. The existing ginning factories are situated at Suakin, with 46 gins, at Zeidab, with 11 gins, at the Gordon College, Khartoum, with 8 gins, at Kassala, with 3 gins, and at Wad Medani, with 5 gins.

Samples of cotton from most of the cotton-growing districts of the Sudan have been received recently at the Imperial Institute, and an account of their examination is given in the succeeding pages. It should be pointed out that, in all cases except where otherwise indicated, the samples are representative of the ordinary cultivation of the country, and that none of them has been specially selected as typical of the best cotton which can be produced in the Sudan.

Samples from the Tokar District, Red Sea Province

As already mentioned, experiments have been in progress in Tokar with the object of testing the suitability of a number of varieties of cotton to the climate. Some difficulty has been experienced in carrying out the experiments, as the flood is very erratic and the irrigation of the land irregular, so that it was not possible in some cases to ensure that the different varieties were grown under identical conditions.

The chief experiment in 1910–11 was a comparative trial of three Egyptian varieties—Mitafifi, Abassi, and Nubari, and six Improved American cottons—King's American, Simpkins's, Cook's, Allen's Improved, Sunflower Improved, and Griffin's Improved. Of the Egyptian varieties Mitafifi proved superior in yield to Abassi, and although the latter gave a better lint, it was considered that the former would prove the more profitable for cultivation in Tokar. The area devoted to Nubari was indifferently irrigated, so that the yields cannot be compared with the other varieties, but in all probability the yield will prove considerably less. The results in the case of the American cottons were not thought to be conclusive, but Simpkins's, Allen's Improved, King's American, and Griffin's Improved were considered worthy of further investigation. The American cottons gave a yield one-half to three-quarters as much again as Mitafifi on moderately irrigated land, and the difference in favour of the former increases the lighter the irrigation. The Mitafifi cotton gave a higher percentage of lint and cost less to gin, but the experiments are to be continued before

any definite recommendations are made as to the relative values of the two kinds of cotton for cultivation.

The average yields of seed-cotton obtained on moderately and lightly irrigated lands are shown in the following table:

Variety.	Average yield per acre.	
	Moderately irrigated.	Lightly irrigated.
	lb.	*lb.*
Mitafifi	906	593
Abassi	530	355
Simpkins's	1,476—1,610	—
Allen's Improved	1,260	712
King's American	1,240	980
Sunflower Improved	980	—
Cook's	—	955
Griffin's Improved	—	683

Ginned samples of all the foregoing varieties, each weighing about 100 lb., were received at the Imperial Institute, and were examined with the following results. The bulk of the samples was sold subsequently at Liverpool in October 1911.

No. 1. *Mitafifi.*—Two samples of this variety were received. One was grown on land newly cleared of scrub, and received moderate irrigation. The average yield per acre in this case was 863 lb. The cotton, which was stated to represent the first pickings, was clean, fairly soft, rather dull, fine, of uneven brown colour, and free from stains, but contained a small proportion of white cotton. It was of very good strength, and mostly from 1·3 to 1·6 in. in length, but a small proportion measured about 1·0 to 1·3 in.

This cotton was of good quality, but somewhat lacking in lustre and rather uneven in length and colour. It was sold at 9*d.* per lb., and the brokers reported that it was of a grade intermediate between "good" and "fully good fair" brown Egyptian.

The second sample of Mitafifi cotton was grown on well irrigated land. The average yield of seed-cotton per acre was 1,101 lb., the highest yield from a single acre being 1,518 lb. This sample also represented the

first pickings, and consisted of clean, fairly soft, fine, moderately lustrous cotton of somewhat uneven brown colour and free from stains. It was of very good strength, and varied in length from 1·3 to 1·6 in.

This cotton was also of good quality, and of better colour and more regular length than the first sample. The brokers reported that it was of "fully good fair" grade and of good style. It realised 9*d.* per lb.

No. 2. *Abassi.*—This consisted of clean, fairly soft, fine, lustrous, white cotton, with occasional brown stains. It proved to be of good strength, and varied in length from 1·3 to 1·6 in., but was mostly about 1·5 in.

This cotton was of excellent quality and good silky staple, and was sold at 10*d.* per lb.

No. 3. *Nubari.*—This cotton was clean, soft, fine, lustrous, of rather uneven brown colour, and free from stains. It was of very good strength, and varied in length from 1·3 to 1·6 in., but was mostly about 1·5 in.

This cotton was also of excellent quality but of rather uneven colour. It was sold at 10*d.* per lb.

No. 4. *King's American.*—This consisted of clean, soft, fine, lustrous, cream-coloured cotton, almost free from stains. The strength was fairly good, but the length somewhat irregular, varying from 1·0 to 1·6 in., mostly from 1·1 to 1·3 in.

This cotton was of good quality, although rather irregular in length. Some of the fibres were rather longer than is usual for this variety, which generally has a staple of 1·0 to 1·2 in. It was sold at 8*d.* per lb.

No. 5. *Simpkins's.*—This cotton was clean, fairly soft, very lustrous, fine, cream-coloured, and free from stains. It was of good strength, but somewhat irregular in length, varying from 1·0 to 1·7 in., but mostly from 1·2 to 1·3 in.

This cotton was of somewhat irregular length, but was otherwise of very good quality. Some of the fibres were unusually long for this variety. It was sold at 8*d.* per lb.

No. 6. *Cook's.*—This consisted of soft, fine, lustrous cotton of pale cream colour and free from stains, but slightly "leafy." It was of good strength and varied in length from 0·9 to 1·1 in.

This cotton was of good quality, but rather short. "Cook's" variety usually has a length of about 1·5 in. It was sold with the next sample at 5·07*d.* per lb.

No. 7. *Allen's Improved.*—This cotton was clean, soft, fine, of good lustre, and white to pale cream in colour and almost free from stains. It was of good strength but rather irregular in length, varying from 1·0 to 1·7 in., but was mostly about 1·0 to 1·2 in.

This cotton was of good quality, although irregular in length. This variety usually has a staple of about 1·2 to 1·4 in. It was sold with the preceding sample at 5·07*d.* per lb.

No. 8. *Sunflower Improved.*—This sample consisted of soft, fine, lustrous cotton of cream colour with occasional brown stains, and slightly "leafy." It was somewhat uneven in strength and varied in length from 1·0 to 1·5 in., but was mostly from 1·0 to 1·3 in.

This cotton was of good quality, but somewhat uneven in strength. It was sold with the next sample at 5·19*d.* per lb.

No. 9. *Griffin's Improved.*—This cotton was soft, fine, of good lustre, and of white to pale cream colour. A few bright yellow stains were observed. It was of good strength, but the length was somewhat irregular, varying from 1·0 to 1·6 in., but mostly from 1·0 to 1·3 in.

This cotton was of irregular length, but it was otherwise of good appearance and quality. It was sold with the preceding sample at 5·19*d.* per lb.

On the whole, these cottons from the Tokar district were of very satisfactory quality, being all of good colour and free from stains.

The Egyptian varieties gave better results than the "improved" American kinds, most of the latter exhibiting considerable irregularity in length of staple.

The brokers who sold the cotton in Liverpool gave the following preliminary valuations on samples forwarded to them from the Imperial Institute: Mitafifi, 9¼*d.* to 9½*d.* and 10*d.* to 10¼*d.* per lb. respectively, with "fully good fair" Mitafifi at 9$\frac{15}{16}$*d.* per lb.; Abassi, 12*d.* per lb., with "fully good fair" Abassi at 12⅜*d.* per lb.; Nubari, about 11*d.* per

lb., with "fully good fair" Nubari at 10⅞*d.* per lb.; King's, 9·00*d.*, Simpkins's, 8·50*d.*, Cook's, 7·00*d.*, Allen's, 7·00*d.*, Sunflower, 7·50*d.*, Griffin's, 7·75*d.* per lb., with "middling" American at 7·11*d.* per lb.

The brokers stated, when giving the above valuations, that it is not possible to obtain anything like the full commercial value for such small consignments as those now under report, and this is borne out by the results of the sale.

Larger consignments of all these cottons except Nubari were also sent direct from the Sudan to Liverpool and were sold there in four lots in September 1911 at the following prices: Mitafifi, 9⅜*d.* per lb.; Abassi, 10*d.* per lb.; King's American, Simpkins's, and Cook's, 7*d.* per lb.; Allen's Improved, Sunflower Improved, and Griffin's Improved, 7*d.* per lb.

Samples from Berber Province

Eleven samples, mostly of Egyptian varieties, grown either at the Zeidab or Fadlab Estates of the Sudan Plantations Syndicate, have been received from this Province.

No. 1. *Mitafifi.*—This sample, received in October 1910, consisted of fairly soft, lustrous, clean cotton of pale brownish colour and free from stains. It was of good strength and varied in length from 1·2 to 1·8 in., but was mostly from 1·4 to 1·7 in. The diameter ranged from 0·00055 to 0·00090 in., with an average of 0·00070 in.

This sample was of good quality, and such cotton would be readily saleable in the English market. It was valued at 13*d.* to 13½*d.* per lb., with "good" brown Egyptian at 13*d.* per lb.

No. 2. *Abassi.*—This was received in May 1909. It consisted of clean, soft, fairly silky cotton of very good lustre and even, pale cream colour, and was entirely free from stains. It was of normal strength, and varied in length from 1·3 to 1·7 in. The diameter of the fibres ranged from 0·0004 to 0·0010 in., with an average of 0·00068 in.

This cotton was of the usual Abassi type. It was of excellent quality, and would be readily saleable, and was

regarded as being worth about 9*d.* per lb., with "good" Abassi at 9½*d.* per lb.

No. 3. *Nubari.*—Three samples of this variety were received in May 1909, October 1910, and April 1911 respectively.

The first sample consisted of clean, soft, silky cotton of good lustre, but rather irregular in colour, being generally pale reddish-brown, but containing occasional white portions; it was free from stains. The strength was normal on the whole, but some portions were rather weak. The length varied from 1·2 to 1·7 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00068 in.

Apart from the slight irregularity in colour, this cotton was of excellent quality, and was valued at about 9½*d.* per lb., with "fully good fair" brown Egyptian at 9$\frac{5}{16}$*d.* per lb.

The second sample of Nubari cotton was soft, lustrous, and of cream colour, with a slight brownish tint. The material was free from stains, but some fragments of "leaf" and broken seed were present. The strength was fairly good, and the length varied from 1·1 to 1·7 in., but was mostly from 1·2 to 1·5 in. The diameter ranged from 0·0005 to 0·0008 in., with an average of 0·00068 in.

This sample was of good quality, and such cotton would be readily saleable in the English market. It was regarded by brokers as equal in value to "barely good" Egyptian Nubari cotton, and worth 13¼*d.* to 13½*d.* per lb., with "good" brown Egyptian at 13*d.* per lb.

The third sample of Nubari cotton consisted of fairly soft, clean cotton of moderate lustre, fine, pale cream to faint reddish-brown in colour, and free from stains. It was of fair strength, and somewhat irregular in length, varying from 1·0 to 1·7 in., but was mostly from 1·3 to 1·6 in.

This cotton was of good quality, but it was rather uneven in length. It was valued at 10½*d.* per lb., with "good" Nubari at 10¾*d.* per lb.

No. 4. *Voltos.*—Two samples of this variety were received in October 1910 and April 1911 respectively.

The first sample consisted of soft, lustrous, clean cotton of white to pale cream colour, and free from stains. It was of uneven strength, some portions being weak. The length varied from 1·2 to 1·8 in., but was mostly from 1·4 to 1·6 in. The fibres ranged in diameter from 0·0005 to 0·0008 in., with an average of 0·00063 in.

This sample was of good quality, but was weaker and rather less silky than Voltos cotton grown in Egypt. It was valued at 14¾*d.* to 15*d.* per lb., with "good" Abassi at 15*d.* per lb.

The other sample consisted of clean cotton of fair lustre, fairly soft, white to pale cream in colour, and free from stains. It was of very good strength, and varied in length from 1·0 to 1·7 in., mostly from 1·3 to 1·6 in., but was somewhat neppy, *i.e.* contained specks or knots consisting of short, unripe fibres. The diameter ranged from 0·0005 to 0·0008 in., with an average of 0·00066 in.

This cotton was of good useful quality, and was chiefly remarkable for its great strength. It was valued at 11*d.* to 11¼*d.* per lb., with standard Voltos at 12*d.* per lb.

No. 5. *Makhsous.*—This sample of seed-cotton was received in April 1911. It yielded on ginning 29·2 per cent. of lint, the yield per 100 seeds being 5·2 grams. The lint was clean, fairly soft, of fair lustre, white to pale cream in colour, and free from stains. The seeds were small, mostly nearly smooth, but tufted at the pointed end, and in some cases partially coated with a brown or green fuzz.

The cotton was of very good strength, but somewhat irregular in length, varying from 1·2 to 1·9 in., but was mostly from 1·5 to 1·8 in. The diameter ranged from 0·0005 to 0·00075 in., with an average of 0·00063 in.

This was a good cotton, of excellent strength, and equal in fineness to Sea Island. The length was rather less than that of the Sea Island variety, and was somewhat uneven. It was valued at 10½*d.* per lb. (January 1912).

No. 6. *Sakellaridis.*—This cotton, received in April 1911, was clean, soft, of good lustre, white to deep cream in colour, and free from stains. It was of irregular strength, but some portions were very strong. The length varied from 1·1 to 1·7 in., but was mostly from 1·4 to 1·6 in.

This was a fine cotton, of high grade, but was rather uneven in strength. It was valued at $11\frac{1}{4}d.$ to $11\frac{1}{2}d.$ per lb., with "best" Sakellaridis at 12*d.* per lb.

No. 7. *Gallini.*—This sample was received in May 1909. It consisted of clean, soft, silky cotton of very good lustre and even pale cream colour, and was generally free from stains. It was, on the whole, of normal strength, but some portions were rather weak. The length varied from 1·6 to 2·0 in., and the diameter ranged from 0·0004 to 0·0009 in., with an average of 0·00062 in.

This sample of "Gallini" cotton, a type of Sea Island grown in Egypt, was somewhat similar to a fair quality of American Sea Island cotton, but was slightly inferior in colour. It would, however, be readily saleable. It was valued at about 10*d.* per lb., with "fancy" Florida Sea Island at 12*d.* per lb.

No. 8. *American.*—This cotton, received in April 1911, was clean, fairly soft, of good lustre, fine, white to pale cream in colour, and free from stains. It was of good strength, but uneven in length, varying from 0·5 to 1·4 in., but was mostly from 0·9 to 1·1 in.

This sample contained some short, broken fibres, apparently owing to bad ginning. In other respects it was of good quality, and of "fully good middling" grade. It was valued at 5·25*d.* per lb., with "middling" American at 5·05*d.* per lb.

Samples from the Gezira Plain

Three samples of seed-cotton from the Gezira have been examined, but in no case was the variety stated.

A sample from Monagil, Blue Nile Province, was received in July 1909. It was very "leafy," and yielded 29 per cent. of lint on ginning, the yield per 100 seeds being 4·7 grams. The lint was soft, lustrous, of rather uneven cream colour, but fairly free from stains. The seeds were of medium size, smooth, dark brown, with greenish-brown tufts at the pointed ends. All the seeds examined appeared to be healthy, and free from the attacks of insect pests.

The cotton was rather uneven in strength, some por-

tions being very weak. The length varied from 1·4 to 1·7 in., and the diameter ranged from 0·0004 to 0·0009 in., with an average of 0·00066 in.

This cotton was of Egyptian type, but it was considerably less silky than a standard sample of Egyptian Abassi cotton with which it was compared. Although somewhat uneven in strength, owing to the presence of immature fibres, the sample was of good quality, and such cotton would be readily saleable. It was valued at about 10*d.* per lb., ginned, with good Abassi at 12⅜*d.* per lb., and "middling" American at 7·59*d.* per lb.

A sample grown at Singa, Sennar Province, was received in April 1911. It yielded, on ginning, 34·0 per cent. of lint, the yield per 100 seeds being 4·9 grams. The lint was clean, fairly soft, of fair lustre, white to pale cream in colour, and free from stains. The seeds were of medium size, some partly covered with white or green fuzz, others only tufted at the end. A few seeds were withered.

The strength of the cotton was uneven, but on the whole fairly good. It was somewhat irregular in length, varying from 0·7 to 1·6 in., but was mostly from 1·0 to 1·4 in. The diameter ranged from 0·0005 to 0·001 in., with an average of 0·00076 in.

This sample was irregular in strength, and in the length and diameter of the fibres. This was doubtless due to the fact that a considerable proportion of the cotton was not fully mature. It was valued at 8½*d.* per lb., with "fully good fair" Abassi at 10¼*d.* per lb.

A sample of seed-cotton of Egyptian type, grown as a rain crop at Abu Hashim, Sennar Province, was received in April 1911. It yielded, on ginning, 30·3 per cent. of lint, the yield per 100 seeds being 4·3 grams. The lint was clean, soft, of good lustre, fine, white to light brown in colour, and free from stains. The seeds were of medium size, and mostly smooth and dark brown. About 13 per cent. were light brown, and more or less withered.

The cotton was of fair strength, and varied in length from 1·0 to 1·7 in., but was mostly from 1·3 to 1·5 in.

This cotton strongly resembled Mitafifi, and was so regarded by commercial experts, to whom it was submitted

for valuation. It was rather uneven in colour and length, and was valued at 9*d.* per lb., with "fully good fair" brown Egyptian at the same price.

Sample from Kassala Province

A sample of seed-cotton of American type, grown on the Setit River, was received in August 1911. The yield of lint on ginning was 28·5 per cent., and 3·67 grams per 100 seeds. The lint was soft, fairly lustrous, fine, white to pale cream in colour, and free from stains. Occasional fragments of "leaf" were present. The seeds were of medium to small size, and mostly covered with a white fuzz; a few dark brown seeds were also present.

The strength of the cotton was somewhat uneven, being mostly rather weak. It varied in length from 1·0 to 1·5 in., but was mostly from 1·3 to 1·4 in. Some very short fibres were also noticed.

This cotton was of fairly good quality, and resembled American Upland in type. The chief defects were the irregularity in length and strength. These faults could no doubt be remedied by careful selection of the seed used for sowing and the exercise of special care in cultivation. The sample was valued at about 5⅜*d.* per lb., with "middling" American at 5¼*d.* per lb.

Sample from Mongalla Province

A sample of seed-cotton from Mongalla Province was received in October 1911. The cotton was stated to be growing wild; it was not considered to be native, but probably descended from seed introduced from Egypt in the past.

The sample was rather "leafy" and dirty. It yielded, on ginning, 33·5 per cent. of lint, the yield per 100 seeds being 6·8 grams. The lint was soft, fairly fine, moderately lustrous, and varying in colour from cream to brown, with occasional brown stains. The seeds were dark brown in colour, of medium size, bearing tufts of green down. About 15 per cent. of those examined were diseased or withered.

The cotton was of fair strength and irregular in length, varying from 0·8 to 1·5 in., but was mostly from 1·0 to 1·3 in.

This cotton appeared to be a somewhat deteriorated form of Mitafifi. The length and colour had become rather irregular owing to the plants having been grown without cultivation. The product was, however, of promising quality, and the plants, having been acclimatised to the country, would probably prove hardy and give good results if careful cultivation and selection were adopted. The sample was valued at 8½*d.* per lb., ginned, with "fully good fair" brown Egyptian cotton at 9*d.* per lb.

JUTE FROM THE SUDAN

A sample of jute, resulting from an experimental trial at Kodok, Upper Nile Province, was received at the Imperial Institute in 1911 and submitted to examination. It consisted of soft, lustrous fibre, of very pale straw to buff colour. On the whole, the product had been well prepared, but occasional portions were slightly gummy. It was mostly of very good strength, and had an average length of about 4 ft. 6 in.

On chemical examination, the fibre yielded results which are compared below with those furnished by a specimen of Indian jute of "extra fine" quality.

	Present sample. *Per cent.*	"Extra fine" Indian jute for comparison. *Per cent.*
Moisture	9·2	9·6
Ash	2·2	0·7
α-Hydrolysis, loss	10·7	9·1
β-Hydrolysis, "	17·0	13·1
Acid purification, loss	2·2	2·0
Cellulose	72·1	77·7
Loss on boiling with water for 5 minutes	1·3	—

In chemical composition and behaviour the present sample is somewhat inferior to the "extra fine" Indian jute used for comparison, as it loses more on hydrolysis and contains less cellulose, and on this account would probably prove to be slightly less durable. It was, however, of good quality, being generally of good colour and lustre, of excellent strength, and of medium length, and would be readily saleable. The fibre was regarded by commercial

experts as worth £24 per ton in London when "First Native Marks" Calcutta jute was quoted at £25 per ton.

These results must be considered as very satisfactory in view of the fact that the seed was sown rather late in the season and that in consequence the plants ripened very rapidly and formed seed before harvesting could be effected.

THE FIBRE OF *CALOTROPIS PROCERA*

CALOTROPIS PROCERA, R. Br., is a shrubby plant growing about 5 to 6 ft. high, belonging to the Natural Order Asclepiadaceæ. In common with other plants of this order, the stems of *C. procera* contain latex and the seeds are provided with fine, silky hairs which constitute a useful floss (see this BULLETIN, 1905, **3**, 222).

The plant occurs abundantly in parts of India, the Malay Archipelago, and South China, where it is associated with a closely allied species, *C. gigantea*, R. Br.

It also occurs in Persia and is widespread over practically the whole of tropical Africa. An enquiry carried out in 1905 showed that *C. procera* is common in all the provinces of the Anglo-Egyptian Sudan, except Halfa Province, where it occurs only occasionally. In many parts the plant is found only on the sites of former cultivation; in Khartoum, Berber, White Nile Provinces, and elsewhere it is most common on land near the Nile (*Monthly Rep. Centr. Econ. Bd. Khartoum*, 1912, **6**, 107).

C. procera and *C. gigantea* are closely allied botanically and they yield similar products, and for this reason it is difficult to obtain definite information from published records as to the individual merits of the two plants. Both plants yield a valuable bast fibre known in India as "Madar" fibre. This is said to be one of the best of Indian fibres, possessing many of the qualities of flax, but is somewhat finer. It is of considerable strength, a rope made of it breaking under a weight of 407 lb., whilst a similar rope of cotton broke under 346 lb. and one of coir under 224 lb. The fibre is prepared in India by hand without previous retting, as this latter process is thought to rot the fibres. Only a small amount is produced in India, for special

purposes. In the Sudan it is stated that the fibre is prepared by the natives by steeping the stems in water for a short time and then burying them under a few inches of earth, the whole process lasting only twenty-four hours. The stems are then washed and the fibre is extracted by hand.

The floss of *C. procera* and *C. gigantea* has long been used in India for stuffing pillows, etc., its soft, light character rendering it of special value for this purpose. It could also be used, either alone or in admixture with cotton, in the manufacture of plushes, laces, and other materials; machinery for spinning this and similar flosses has recently been devised (see this BULLETIN, 1911, **9**, 71).

According to Dodge, plants spaced 4 ft. by 4 ft. will yield 10 tons of green stems per acre and 582 lb. of bast fibre, equivalent to a yield of about 2·6 per cent. So far, however, no attempt has been made to cultivate the plant on a commercial scale.

A sample of the bast fibre of *C. procera*, from the neighbourhood of Nahud, Western Kordofan, Sudan, was received recently at the Imperial Institute under the name of "Ushar" fibre, and the results of its examination are given below.

The sample consisted of a bundle of fibre varying in colour from green to white. The green parts were somewhat harsh and gummy, but the white parts were soft. Some of the fibre had been made into small bundles by twisting the strands together at one end for a few inches of their length. The fibre was of fair strength and varied in length from 3 to 5 ft.

It was examined chemically, with the following results, compared with those for the fibre of *C. gigantea* from India, examined at the Imperial Institute.

	Present sample. *Per cent.*	Sample of *C. gigantea* fibre from India. *Per cent.*
Moisture	7·1	8·88
Ash	2·5	3·25
α-Hydrolysis, loss	5·9	10·86
β-Hydrolysis, "	16·2	13·82
Acid purification, loss	4·0	8·58
Cellulose	84·3	84·25
Increase in weight on nitration	61·1	56·96

The length of the ultimate fibres in each case varied from 10 to 30 mm.

This fibre was of good quality and would be suitable for the manufacture of ropes. The sample had been rather unevenly cleaned, however, and the twisting of the ends would be objectionable in the case of a consignment intended for sale, as the value would be reduced owing to the labour required to untwist the fibre before it could be worked. It was valued at £24 per ton, with Mexican Sisal hemp at the same price.

It may be mentioned that in India great difficulty has been experienced in obtaining the bast fibre of *C. procera* or *C. gigantea* of a length much exceeding 12 in., but the sample under report indicates that this difficulty has been surmounted in the Sudan.

THE AFRICAN PALM OIL INDUSTRY.—II.

In a previous article in this Bulletin (1909, **7**, 357) a general account was given of the distribution of the oil palm in Africa, the methods of preparation of palm oil and palm kernels, statistics of trade in these products, and particulars of their properties and uses. A summary was also given of the results of investigations at the Imperial Institute of the fruits of the numerous varieties of oil palm occurring in the Gold Coast and Southern Nigeria, and the relative advantages of these various types as sources of palm oil and palm kernels were discussed. That article was published at a time when various European firms were beginning to take an interest in the possibility of organising the production of palm oil in West Africa under European supervision, and since then great developments have occurred in this direction. The manufacture of palm oil under European auspices in West Africa implies the use of machinery, and a large number of machines have been devised for this purpose in the last few years, some of which have been referred to in this Bulletin from time to time (1910, **8**, 58; 1912, **10**, 492; 1913, **11**, 155). There are a number of others of which details are not available for publication. A considerable quantity of palm oil and palm kernels is already

being extracted by machinery in factories managed by Europeans in West Africa, and there seems no reason to doubt that this will be largely augmented in the next few years, and it seems possible that palm oil made by native processes may eventually disappear from commerce and that the function of the native in the future will be to collect the fruits and transport them to the nearest factory, to be worked up into palm oil and palm kernels. This will have the advantage of liberating an immense amount of labour, which is at present wastefully employed, and may eventually have a profound influence on agricultural development in the chief oil producing countries, where at present the absorption of native labour in the palm oil industry is one of the most serious obstacles to the introduction or extension of other crops.

In the present article it is proposed to give some account of further investigations in connection with the oil palm that have been made at the Imperial Institute since the previous article was published. These have included the examination of a number of samples of palm fruits, nuts, kernels, and oils from the Gold Coast, Southern Nigeria, Nyasaland, Uganda, and Mozambique. Some of this work has reference mainly to the determination of the value of new kinds of palm fruit as sources of oil and kernels, others to the quality of the oil produced by natives by different processes, and a third part to the possibilities of the Gwira machine, a small appliance designed for use by natives.

Details of the Gwira machine mentioned in the previous article (*loc. cit.* p. 387) have been supplied to the Imperial Institute by the Agricultural Department, Gold Coast. This machine was devised to meet the needs of the small native producer, and is consequently of small size. It can be carried by two men, and it is claimed that it can be worked to yield 8 to 10 gallons of oil per day by three natives. It consists of a cylinder, capable of taking a charge of 100 lb. of fresh fruits, made in two halves bolted together and mounted horizontally on a stand. Six blades are fixed on the inside of the cylinder, and a shaft bearing seven double blades fixed at various angles passes through

its centre. The shaft can be rotated by a handle at each end. The revolving blades remove and break up the pulp. The bottom of the cylinder is lined with wire gauze or fine wire netting, which acts as a strainer. The fruits are first boiled in water to soften the pulp, and then placed in the cylinder with boiling water and "pulped" for about five minutes by turning the handles. The oil and water are then run off through a tap in the bottom of the cylinder and fresh boiling water added, the process being repeated once or twice until the greater part of the oil has been removed. The oil is finally separated from the water in the ordinary way by heating and skimming.

A number of trials with the Gwira machine have been made in the Gold Coast, and specimens of the oil and residual fibre obtained in the course of the experiments have been examined at the Imperial Institute (see p. 210). So far the trials have not been altogether satisfactory, as the percentage of oil removed from the pulp is lower than by the usual native method. It seems probable that the machine could be improved by having a basin-shaped drainage space above the outlet tap, to prevent clogging, whilst the cylinder could be enlarged with advantage, to take a charge of 150 lb. or more of fresh fruits. Various other improvements have been suggested by Mr. Evans, of the Agricultural Department, Gold Coast, who considers that in its present form it is not likely to be used on a large scale by the natives, as there is a tendency for it to get out of order.

Oil-palm Products from the Gold Coast

The materials received in recent years from the Gold Coast include fruits of two varieties of oil palm not previously described in this Bulletin, oil and residual fibre produced in experiments with the Gwira pulping machine, specimens of the fruits used in one of these experiments, and oils obtained in the course of fermentation experiments.

"*Adi-be*" *Palm Fruits.*—This consisted of a mixture of large and small fruits, which had been gathered from one bunch.

The large fruits had thick pulp and contained medium-sized nuts resembling those of "Abobo-be" palm fruits (*loc. cit.* p. 367), with thin shells and globular kernels. The small fruits were narrow and elongated, containing no nuts but only a small fibrous mass at the centre. They resembled immature fruits as found in most heads of palm fruits, but the "embryo" nut was smaller.

The size and weight of the fruits were as follows:

	Large fruits.			Small fruits.
	Fruits.	Nuts.	Kernels.	
Average length, *inches*	1·4	0·7	0·50	1·05
Average diameter, *inches*	0·8	0·6	0·45	0·40
Average thickness of shell, *inches*	About	0·05 or	less	—
Average weight, *grams*	6·7	2·5	1·1	1·5

A mixture of large and small fruits in the proportion of 2 to 3, as in the sample received, was found to have the following composition: The fruit contained 72 per cent. pulp, 28 per cent. nut, and 12·5 per cent. kernel. The pulp of the fruit contained 14·5 per cent. moisture and 62·2 per cent. oil (equivalent to 44·8 per cent. in the whole fruit and 72·7 per cent. in the dry pulp). The nuts contained 55 per cent. shell and 45 per cent. kernel. The amount of moisture and oil in the kernels could not be determined owing to the small size of the sample.

This fruit is a thin-shelled variety, which would give a good yield of palm oil and a fair yield of kernels. It would be of interest to know if the relative proportions of large fruits with nuts to small fruits without nuts is naturally the same as in the sample supplied.

"Abe-dam-Adi-be" Palm Fruits.—This variety derives its name from the fact that the fruits are pale in colour like those of "Abe-dam," and possess a thick pulp like those of "Adi-be." It may be a hybrid between these forms, but both of these varieties have thick, hard endocarps, whilst the present example is practically "shell-less," as mentioned below. So far only one tree of this variety has been seen, which is growing at a village near Aburi.

The sample consisted of somewhat small palm fruits,

resembling "Abobo-be" fruits in shape and general structure, except that the kernel in most cases had no hard, woody shell, but only a very thin, brown coat or a thin layer of dark brown fibres surrounding it. A few of the fruits contained nuts with a very thin, brittle shell, but for practical purposes they may be termed "shell-less." The kernels were small and almost spherical.

The average lengths of the fruits and kernels were 1·25 in. and 0·50 in. respectively; the average diameters 0·65 in. and 0·43 in.; and the average weights 3·95 and 0·75 grams. The proportion of pulp in the fruits amounted to 82 per cent., and it contained 27·7 per cent. moisture and 50·9 per cent. oil (equivalent to 41·7 per cent. in the whole fruits and 70·2 per cent. in the dried pulp). The quantity was too small to allow of determination of the amount of moisture and oil in the kernels. It has, however, been shown by previous analyses that the percentage of oil in the kernels of different varieties of palm fruit only varies between narrow limits *(loc. cit.*, p. 390).

These palm fruits gave a good yield of oil and a fair yield of kernels. The economic importance of the variety will, however, depend entirely on the possibility of reproducing it from seed.

Experiments with the Gwira Pulping Machine.—An experiment with this machine was conducted in the Gold Coast in 1910. Sixty pounds of fresh palm fruits yielded 15·52 per cent. of oil, 58·33 per cent. of nuts, and 10 per cent. of fibrous residue, the "loss" being 16·14 per cent. A sample of the oil and one of the fibrous residue, as collected from the machine, have been examined at the Imperial Institute.

The oil was clean, orange-red in colour, and of good quality. It contained only 0·85 per cent. of moisture and 0·03 per cent. of impurity.

The following results were obtained on examination:

Specific gravity at $\frac{100^\circ \text{ C.}}{15·5^\circ \text{ C.}}$	0·858
Acid value	10·4
Saponification value	199·7
Iodine value, *per cent.*	51·0
Titer test	43·5° C.

This oil had the usual chemical characters of good-quality palm oil. It was of good colour, and free from any appreciable amount of moisture or dirt, and such palm oil would be readily saleable in Europe, at good prices, as "soft" palm oil.

The fibrous residue was found to contain 9·6 per cent. of moisture and 34·2 per cent. of oil, or 37·8 per cent., calculated on the dry material. The oil, as extracted by solvents from the fibrous residue, was hard and of pale colour, and consisted chiefly of fatty acids.

Residual fibrous pulp obtained in the extraction of palm oil by the usual native method in Southern Nigeria, examined at the Imperial Institute, contained only 31 per cent. of oil, calculated on the dry material, as compared with 37·8 per cent. in the present instance. The fibrous pulp from Southern Nigeria was obtained in the extraction of palm oil by the usual native method, and it would thus appear that the Gwira machine does not extract as large a proportion of the oil from palm fruits as the native process does. This is probably due to the fact that no pressure is exerted on the pulp in the machine, the oil being merely washed out, whereas in the native process the pulp is squeezed by hand. Some of the oil retained in the present sample of machine-prepared fibrous residue was readily extracted by wrapping the material in a cloth, immersing for a few minutes in boiling water, and wringing by hand.

The bulky, fibrous nature of this residual pulp renders complete extraction of the oil by mechanical means impossible, but it should be easy to obtain a good yield of oil by re-heating the material with water and subjecting it to pressure in simple screw, lever, or wedge presses, or even by hand.

A second experiment was carried out in 1912, the materials employed consisting of equal quantities of the fruits of the "Abe-pa," "Abe-dam," and "Abe-tuntum" varieties, which were described previously (this BULLETIN, 1909, 7, 366). Five lots of fruits, each lot weighing 80 lb., were pulped. The fibre and nuts were washed after coming from the machine, and the oil and water squeezed from

the fibre by hand. The yield of oil ranged from 13·75 to 16·25 per cent., and the percentage of fibrous residue from 7·5 to 10·0. A sample, representative of the fruits used in this experiment, and some of the fibrous residue obtained, were received for examination.

The palm fruits were orange-red in colour, in good condition, with thin pulp and thick-shelled nuts. The pulp formed 30 to 31 per cent., and the nuts 69 to 70 per cent. by weight of the fruits; the nuts consisted of 70 per cent. of shells and 30 per cent. of kernels. These proportions of shell and kernel agree with the results obtained for samples of thick-shelled palm nuts previously examined at the Imperial Institute (*loc. cit.* p. 368).

The pulp of the fruits as received contained 5 per cent. of moisture, and 72·1 per cent. of oil, equivalent to 75·8 per cent. of oil in the dry pulp. In the case of previous samples of palm fruits examined at the Imperial Institute, the pulp has contained as much as 31 per cent. of moisture, and even this is probably exceeded in the freshly-gathered fruit, so that it is clear that the sample under report had dried considerably during transit to London. It may be pointed out that the amount of moisture present in the fruits when pressed must be taken into account when comparing the yields of oil in different instances.

The fibrous material was found to contain 10 per cent. of moisture, and 36 per cent. of oil, equivalent to 40 per cent. in the dry fibre. The fibre therefore contained rather more oil than that obtained in the previous experiment with the Gwira machine, and considerably more than the residue obtained by the usual native method of pressing palm fruits (see p. 211). The samples so far examined at the Imperial Institute have therefore not indicated that the Gwira machine extracts as much of the oil from the palm fruits as the usual native method.

Palm Oils obtained in Fermentation Experiments.—An experiment designed to ascertain the effect of fermentation of the fruit on the quantity and quality of the oil was carried out by the Agricultural Department, Gold Coast, in 1912. The yield of oil, as obtained by the Gwira machine, was as follows: From fresh fruits extracted on

the day of gathering, 10 per cent.; from fruits fermented for eight days before extraction, 11·25 per cent.; from fruits fermented for six weeks, 9·82 per cent. The yield in each case was low, and further experiments are necessary before the results can be taken as decisive.

A sample of each of these oils was received for examination. The oil prepared from fresh fruits and that prepared from fruits fermented for eight days were soft and had the normal appearance of palm oil; that prepared from fruits fermented for six weeks also had the appearance of palm oil, but it was much harder than the other samples.

In order to ascertain the effect of the fermentation on the composition of the oil, the acid values of the three samples were determined. This constant indicates the extent to which the oil has become rancid and "hard." The following results were obtained:

	Acid value.
Oil from fresh fruits	8·4
Oil from fruits fermented 8 days	13·2
" " " 6 weeks	103·7

These figures show that the first two are "soft" oils with a low acid value, whilst the third is a "hard" oil with a high acid value. For comparison with the above results the following acid values, recorded for typical "soft" and "hard" commercial palm oils, may be quoted:

"Soft": Lagos palm oil	25 to 26
"Hard": Congo "	151 to 167

The value of "hard" oil is much lower than that of "soft" oil, as will be seen from the following prices recently quoted in Liverpool: Lagos, "soft" oil, £31 5*s.* to £31 7*s.* 6*d.* per ton; Congo, "hard" oil, £26 to £26 5*s.* per ton (April 1913).

The results of this investigation conclusively show that the effect of allowing palm fruits to ferment for a considerable period is to produce a "hard" oil of much lower commercial value than the "soft" oil prepared from the fresh fruits.

Oil-palm Products from Southern Nigeria

The oil-palm products received for examination from Southern Nigeria have included fruits of a new variety of oil palm and nine samples of palm oil. The latter were collected by Mr. J. H. J. Farquhar, of the Forest Department in Southern Nigeria, in the course of an enquiry into the palm oil industry of the country.

The results of Mr. Farquhar's enquiry have been embodied in a report, entitled *The Oil Palm and its Varieties*, published this year. Mr. Farquhar refers the oil palms occurring in Southern Nigeria to two groups: (i) the king palm (*Elæis guineensis* var. *Thompsonii* and (ii) the type form of *E. guineensis*, of which two sub-varieties are recognised.

The king palm is a well-known form, and has been recognised by most writers as distinct from the ordinary oil palm (this Bulletin 1909, 7, 382), and by some is regarded as a separate species. It occurs in Southern Nigeria, chiefly in the sandy country bordering the sea-shore and lagoons, and is common in the vicinity of Lagos. It is not found in the dry zone, and is very scarce in the Central Province. Where found at all it constitutes not more than 15 per cent. of the total number of oil palms in the locality. The forms known to the Yorubas as "Ope Ifa" and to the Benins as "Ivioronmila" are regarded by Mr. Farquhar as belonging to this variety.

The type form of *E. guineensis* is the ordinary thick-shelled variety of West Africa and is apparently identical with the *E. guineensis* var. *macrosperma* of Welwitsch. It includes those palms known to the natives as "Ope-pankora" (Yoruba dialect), "Ak-po-ro-jub" and "Okporo-Eyop" (Efik), "Ok-po-ruk-pu" (Ibo), "Udin" (Benin), and "Ikrok-Eyop" (Ibibio). Mr. Farquhar considers that this palm comprises at least 98 per cent. of the total number of oil palms in Southern Nigeria, and possibly nearer 99·8 per cent.

The first sub-variety of the type form appears to be identical with the *E. guineensis* var. *microsperma* of Welwitsch, the "Abobe-be" palm of the Gold Coast, and the

"Lisombé" variety of Kamerun (*loc. cit.* p. 367). The palms known as "Ope-arunfo" (Yoruba dialect), "A-sog-e-jub" and "Osok-Eyop" (Efik), "Osuku" and "Au-suk-ku" (Ibo), "Eduege-Eyop" (Ibibio), and "Ogiedi" (Benin), are regarded as belonging to this variety. It is distinguished from the other forms only by the character of its fruit, which is twice as long as broad, and dark claret-brown in colour when ripe, except at the point of attachment, which is yellowish-red; the mesocarp is thick and fleshy, the shell thin, and both nut and kernel are round. This palm is considered to be very rare, not exceeding 0·2 per cent. of the total number of palms in Southern Nigeria. It is most common in the Eastern Province and less plentiful in the Central Province, and appears to favour the rich alluvial land of the forest region, which has a heavy, well-distributed rainfall.

The second sub-variety includes the "Ojuku" palm of the Ibos and the "Af-fia-ko-jub" of the Efiks. It is considered that 1·8 per cent. of the palms of Southern Nigeria belong to this class. The fruit is pale yellow in colour, shading into a coppery hue when ripe; the kernel is larger than in the type, the shell thicker, and the mesocarp thinner and lighter in colour.

Palm Oils.—The palm oils received at the Imperial Institute were typical of those produced in the Eastern Province, and are described in Mr. Farquhar's report as follows:

1. Bad quality; rancid, with a bad smell and with dark and green patches; bought as a "soft" oil at Calabar.
2. Bad quality, mixed oil, bought at Calabar.
3. Bad quality, mixed oil, bought as a "soft" oil.
4. Oil bought as "soft" oil at Calabar.
5. Oil bought as "hard" oil at Calabar.
6. Oil bought as mixed oil at Calabar.
7. Fresh oil from Ahoada District.
8. Best quality "soft" oil; Eket Opobo.
9. Oil bought as "soft" oil, Oron.

All the samples had the usual colour and appearance of palm oil, and it is therefore unnecessary to describe them in detail. The samples measured about one pint in each case.

It was specially desired to know how these oils would be classified commercially, and, in view of the number of complete analyses of palm oil from Southern Nigeria already made at the Imperial Institute (*loc. cit.*, p. 389), the examination was confined to this point in the first instance. The classification of palm oil on the market depends mainly on the condition in which it is received, and the two principal factors are:

(*a*) The percentage of impurities, such as dirt and water, present in the consignment.

(*b*) The "hardness" or "softness" of the oil.

The results of the examination of the samples are given in the following table:

Number of Sample.	Moisture.	Dirt.	Melting-point of oil.[1]	Acid value.	Glycerine.	
					Calculated from acid value.	Determined experimentally.
	Per cent.	*Per cent.*	°C.		*Per cent.*	*Per cent.*
1	0·55	0·44	38–39°	94·5	6·25	—
2	0·48	0·30	34°	51·6	8·40	—
3	0·80	0·34	34–35°	52·3	8·37	—
4	0·86	0·13	30°	25·4	9·72	—
5	1·10	0·37	34·5°	70·7	7·46	7·2
6	0·94	0·41	36°	72·7	7·37	7·3
7	0·26	0·04	29 30°	11·1	10·45	10·1
8	0·18	0·02	24°	15·6	10·21	—
9	1·05	0·92	39–40°	102·3	5·85	—

[1] *Approximate determinations by open capillary tube method.*

It is clear from these results that all nine samples were satisfactory as regards the percentages of dirt and moisture present, and no serious exception could be taken to any of them on this ground.

The acidity determinations showed that three of these oils (Nos. 4, 7, and 8) had undergone only slight fermentation and would be classed as "soft" oils, whilst four others (Nos. 1, 5, 6, and 9) were highly fermented and would be classed as "hard" oils. The remaining specimens, Nos. 2 and 3, would probably be classed as "mixed" oils, since they were intermediate in acidity between the typically "soft" and the typically "hard" oils. The same classification of the nine oils results from a comparison of their melting-points, but the acidity figures give a much clearer indication of the class to which each oil belongs.

The importance of the distinction between "soft," "mixed," and "hard" oils from a commercial point of view lies mainly in the fact that the inferior "mixed" and "hard" oils, owing to their faulty method of preparation, yield, when used for soap manufacture, less of the valuable by-product, glycerine, than do the "soft" oils, and it is for this reason mainly that they fetch lower prices. The amount of glycerine which can be obtained from an oil or fat can be roughly calculated from the acid value, but as this involves certain assumptions, it was thought desirable in the present instance to check the values thus arrived at by direct determinations of the glycerine in several cases, and the figures obtained in these two ways are given in columns 6 and 7 of the foregoing table.

It is understood that some difficulty has been experienced recently by importers of palm oil owing to the fact that certain West African ports which formerly shipped only "soft" oil have begun to ship "mixed" or "semi-hard" oils.

Mr. Farquhar refers to this matter in connection with shipments of palm oil from Calabar, and explains that this is due to the fact that in recent years the upper reaches of the Cross River have been opened up, and from thence palm oil, prepared in various ways, now reaches Calabar for shipment. Much of the oil from this area appears to be "hard" or "semi-hard," whereas formerly all the oil shipped from Calabar was "soft." There is no satisfactory simple test by which "soft" and "hard" or "semi-hard" oils may be distinguished in the course of actual trading operations in West Africa, and consequently oil purchased as "soft" oil has in some cases turned out to be inferior "hard" oil when examined in Europe. Examples of this are shown in the series of oils dealt with in this report (p. 215). The remedy seems to lie in encouraging the natives to abandon the fermentation process of extracting palm oil, but unfortunately when fresh fruits are employed the process of extraction is more expensive, as it entails the use of large boiling-pots and the consumption of a good deal of fuel, and these are serious difficulties to the natives in some areas.

Palm Fruit.—A sample of palm fruit known to the Efik people as "Ayara Mbana" was received from Calabar in March 1912. The fruits were large, pale brownish-yellow in colour, and of irregular shape. They differed from ordinary palm fruits in being almost enclosed in a thick, oily perianth; as a rule the perianth of the mature fruit, although enveloping the fruit in a similar manner, is dry and scarious. The shells of the nuts were moderately thick and the kernels rather small.

The average weight of the fruits, nuts, and kernels was approximately 8·9, 3·75, and 1·13 grams respectively. The perianth constituted 21·3 per cent. of the fruit by weight, the pulp 35·8 per cent., and the nuts 42·9 per cent. The pulp contained 8·9 per cent. moisture and 76·1 per cent. oil, equivalent to 27·2 per cent. expressed on the whole fruit and 83·5 per cent. expressed on the dry pulp. The nuts consisted of 70 per cent. shell and 30 per cent. kernel, the latter containing 20·1 per cent. moisture and 43·4 per cent. oil, equivalent to 54·3 per cent. calculated on the dry kernel. The perianth contained 10·6 per cent. moisture and 69·9 per cent. oil, equivalent to 14·8 per cent. expressed on the whole fruit and 78·2 per cent. expressed on the dry perianth.

It will be seen that the fruits as received contained 42 per cent. of palm oil, viz. 14·8 per cent. in the outer pulpy covering (perianth) and 27·2 per cent. in the ordinary pulp adhering to the nuts. This yield is almost as large as that given by the "Abobo-be" palm fruit of the Gold Coast or the "A-sog-e-jub" variety of Southern Nigeria (see this BULLETIN, 1909, **7**, 370, 379). The yield of kernels in the present instance is, however, low, being only 12·9 per cent. expressed on the fruits as received.

A variety of palm fruit similar to that under report has been recorded under the name "Klude" as occurring in the Misahöhe district of Togoland (see *Der Tropenpflanzer*, 1904, **8**, 283). The fruit does not appear, however, to have been described as a distinct botanical variety, and it seems not unlikely that it is merely a "sport."

It would be of much interest if the seed of this palm could be grown experimentally in Southern Nigeria, in

order to ascertain whether the offspring would produce the characteristic fruits of the parent plant.

Oil-palm Fruits from Uganda

A consignment consisting of palm fruits of irregular size and shape, having a thin pulp enclosing thick-shelled nuts, was received from Uganda in October 1909. The pulp was very dry, and had mostly been rubbed off in transit. The dimensions and weights of the fruits, etc., were as follows:

	Fruits.	Nuts.	Kernels.
Length, *inches*	1·3 to 2·0	1·0 to 1·75	0·6 to 0·85
Diameter, *inches*	0·7 to 1·55	0·65 to 1·2	0·4 to 0·6
Thickness of shell, *inches*	—	0·1 to 0·35	—
Weight, *grams*	—	3 to 16	0·5 to 2·5

The nuts consisted of 83 per cent. shell and 17 per cent. kernel, and the latter contained 8·2 per cent. of moisture and 46·3 per cent. of oil, equivalent to 50·4 per cent. in the dry kernel. The average weight of the fruits, the percentage of pulp and nut, and the amount of moisture and oil in the pulp could not be determined, owing to the damaged state of the fruits.

The fruits were received in poor condition, but they evidently belonged to the poorest class of oil-palm fruits, having a thin pulp and thick-shelled nuts, and resembled in type such varieties as the "Abe-pa" and "Abe-dam" from the Gold Coast and "Udin" from Southern Nigeria (this Bulletin, *loc. cit.*).

Oil-palm Fruits from Nyasaland

A sample of palm fruits from the north end of Lake Nyasa, where a limited number of palms occur, was received in March 1909. The fruits were large, usually with thick-shelled nuts and thin pulp, but two of the fruits examined contained typical thin-shelled nuts. The average dimensions and weights of the fruits, etc., were as follows:

	Fruit.	Nuts.	Kernels.
Length, *inches*	1·4	1·0	0·6
Diameter, *inches*	1·0	0·7	0·4
Thickness of shell, *inches*	—	0·15	—
Weight, *grams*	12·0	6·2	1·1

The fruits consisted of 49 per cent. pulp and 51 per cent. nuts, the percentage of kernels being 8·6. The pulp contained 3·4 per cent. of moisture and 76·9 per cent. of oil, equivalent to 37·6 per cent. in the whole fruit and 79·6 per cent. in the dry pulp. The nuts consisted of 83 per cent. shell and 17 per cent. kernel; the latter containing 6·8 per cent. of moisture and 48·1 per cent. of oil, equivalent to 51·5 per cent. in the dry kernel.

These Nyasaland palm fruits, like those from Uganda, belonged to the class having a thin pulp and a thick-shelled nut, typically represented by such fruits as the "Abe-pa" and "Abe-dam" of the Gold Coast or the "Udin" of Southern Nigeria. These varieties, however, give smaller yields of palm oil, as a rule, than the Nyasaland fruits. It is of interest to note that two fruits in the present sample had thin-shelled nuts, resembling in this respect the "Abobo-be" variety of the Gold Coast, so that possibly oil palms of this class also occur in Nyasaland.

It is understood that the oil palm does not occur in sufficient quantity in Nyasaland to make the extraction of palm oil or palm kernels of commercial interest in the Protectorate. The results now recorded, however, indicate the class of oil palm which occurs in the country.

Palm Nuts from Mozambique

The oil palm is at present only cultivated on a small scale in the Mozambique Company's Territory in Portuguese East Africa, and supplies are not yet available in large quantities. Two samples of palm nuts from this country have been examined at the Imperial Institute.

The first sample consisted of dry nuts, many of which were covered with dried pulp. The nuts were large and of the ordinary thick-shelled variety, the average dimensions and weight being as follows:

	Nuts.	Kernels.
Length, *inches*	1·1	0·65
Diameter, *inches*	0·8	0·50
Thickness of shell, *inches*	0·15	—
Weight, *grams*	6·7	1·6

The nuts consisted of shell 77 per cent. and kernel 23 per cent. The kernels contained 5·5 per cent. of moisture and 50·5 per cent. of oil of normal character, equivalent to 53·4 per cent. in the dry kernel, and were similar in all respects to ordinary commercial palm kernels. If freed from shell and in good condition the kernels would probably realise the current market price of palm kernels, which is at present about £21 per ton in Liverpool (April 1913).

The second sample closely resembled the first, but gave a rather lower yield of kernels, viz. 19·6 per cent. The approximate average weight of the nuts was 9·3 grams, and of the kernels 1·8 grams.

COPALS FROM MOZAMBIQUE

THE copals dealt with in the following paragraphs have all been received from the Mozambique Company's Territory in Portuguese East Africa during the last three years. They are all "recent" or "fresh" copals, *i.e.* they are derived from existing trees and are therefore quite distinct in type from the more valuable "fossil" or "hard" copals, typified by the so-called "Zanzibar Copal," which is found on the East African mainland, buried in soil from which copal trees have long since disappeared.

Series 1

Three samples of copal were received in December 1909.

No. 1. "M'Zissue, from Chemba, Sena."—This consisted of irregular fragments of hard and somewhat weathered resin, dull and dirty externally. The fracture was vitreous and mostly transparent. The colour was fairly good, but varied in different pieces from pale yellow to brown. A large amount of extraneous matter, consisting of dirt, bark, etc., was present.

No. 2. "Missu, from Chemba, Sena."—This sample

consisted of "tears" of various sizes and large masses of nearly colourless resin with a thin "weathering" crust. The fracture was glassy and transparent, slightly soft and almost colourless. A good deal of bark and partially burnt resin was present.

No. 3. "Megueije, from Chibabava, Mossurize."—This consisted of large "tears" and irregularly shaped fragments of slightly weathered resin, together with a number of smaller pieces. A few pieces contained dirt, portions of bark, etc. The fracture was vitreous, and generally transparent, but in some cases opaque in the centre.

The samples were examined with the following results:

		No. 1.	No. 2.	No. 3.
Moisture	*per cent.*	1·35	0·82	1·63
Ash	*per cent.*	0·55	0·04	0·73
Melting-point [1]		100° C. (approx.)	92° C.	105° C.
Acid number [2]		95·5	73	138

[1] *Determined on powdered resin in a capillary tube.*
[2] *Milligrams of potash required to neutralise one gram of resin.*

Samples Nos. 1 and 3 were completely soluble in a mixture of alcohol and benzene, nearly completely soluble in mixtures of ether and alcohol, and alcohol and turpentine oil, and partly soluble in alcohol, ether, chloroform, benzene, turpentine oil, or a mixture of turpentine oil and benzene. Sample No. 2 behaved similarly to the others except that it was completely soluble in mixtures of alcohol and turpentine oil, and ether and alcohol, and nearly completely soluble in chloroform.

The samples were "melted" until soluble in turpentine oil, when they were found to have lost in weight as follows:

Sample.	Loss in weight. *Per cent.*
No. 1	25
No. 2	10–15
No. 3	25–30

Varnish trials were made with the "melted" resins, with the following results:

Sample.	Character of solution of "melted" resin in turpentine oil.	Colour and nature of varnish on wood.
No. 1.	Rather dirty.	Pale yellow, fairly hard.
No. 2.	Very clear and nearly colourless.	Fine glossy surface, fairly hard.
No. 3.	Yellow.	Clear, pale yellow, fairly hard surface.

The resins were submitted to varnish manufacturers and to brokers. The former reported that the samples were very soft, and on this account not very useful resins for varnish-making. The brokers described them as of poor quality, with much woody and drossy admixture. The latter valued sample No. 1 at about 20*s.* per cwt. in London (February 1910), and samples Nos. 2 and 3 at 25*s.* to 30*s.* per cwt.

Series 2

Two samples were received during 1910, and were as follows:

No. 4. *Tambana, Dzissue.*—This consisted of moderate-sized "tears" of slightly weathered resin. The tears differed greatly in shape and varied in colour from pale yellow to almost black, the former predominating. The fracture was transparent and vitreous. Some "burnt" resin was present in the sample.

No. 5. *Gum Copal from Mossurize.*—This sample consisted of resin varying in shade from almost colourless to dark grey, the former variety constituting the bulk of the material. The resin was in the form of "tears" and broken masses. It had a slight odour, and exhibited a transparent, vitreous fracture. A few pieces of bark were present in the sample.

The samples were submitted to examination with the following results:

		No. 4.	No. 5.
Moisture	*per cent.*	0·7	0·93
Ash	*per cent.*	0·3	0·6
Melting-point		87° C.	81° C.
Acid number		115	126
Saponification number		130	129
Loss on "melting,"	*per cent.*	29·9	12·5

Sample No. 4 was almost completely soluble in mixtures of alcohol with benzene, and alcohol with oil of turpentine, but was only partially soluble in other solvents. The resin, after "melting," gave a rather dark varnish, which produced a fairly hard, glossy surface on drying.

Sample No. 5 gave, after "melting," a pale-coloured varnish, which was fairly hard and of good brilliance.

Sample No. 4 closely resembled samples Nos. 2 and 3, which were valued at 25*s.* to 30*s.* per cwt. in London (February 1910). The product, however, needed cleaning and grading. The other sample was similar, but more dark-coloured resin was present, and if picked free from bark and discoloured resin would be of about the same value.

Series 3

The four samples of copal dealt with below were received in December 1911. The copal was stated to have been collected from "Mgeji" (? Megueije, see sample No. 3) trees growing in the Madanda Forest, and to have been separated into four grades.

Botanical specimens of the tree, which were forwarded by the Director of Agriculture to the Royal Botanic Gardens at Kew, have been identified as *Copaifera Gorskiana*, Benth.

The Director of Agriculture, in forwarding the samples, stated that the tree yielding this copal may reach a height of 80 to 90 ft. when mature, with a circumference of 6 ft. The copal does not exude naturally in sufficient quantity to render its collection remunerative. In one instance, however, more copal was collected from a tree which had been accidentally injured than from thirty uninjured trees, and it is possible that, if the trees were systematically tapped, they would yield copal in fairly large quantities. Experiments are now in progress in Mozambique to test this point.

The samples received were as follows:

No. 6.—Fair-sized tears, up to 1 by 2 in. in size, and varying in tint from almost colourless to very pale lemon-yellow. The resin was mostly transparent, showing practically no traces of weathering and exhibiting a glassy fracture; some cloudy pieces were, however, present. A few pieces had fragments of bark adhering to them, but on the whole the sample was clean and of good appearance.

No. 7.—This sample closely resembled No. 6, but the tears and pieces were smaller and rather less transparent.

No. 8.—Mostly small fragments and dust. A large

proportion of the copal was of fairly good colour, but the sample contained much bark and dirt.

No. 9.—Irregular tears and fragments of different sizes, up to 1½ by 2 in., and varying in tint from nearly colourless to the dark brown of "burnt" resin. The smaller pieces were mostly transparent, but the larger pieces contained bark.

The samples were examined with the following results:

		No. 6.	No. 7.	No. 8.	No. 9.
Moisture .	*per cent.*	0·32	0·47	1·64	1·13
Ash . .	*per cent.*	0·26	0·35	5·40	1·52
Melting-point:					
Resin softens at (approx.)		70° C.	70° C.	[1] 80° C.	70° C.
Resin melts at (approx.) .		105° C.	105° C.	[1] 124° C.	105° to 115° C.
Acid number		132	128	156	115

[1] *It was impossible to remove all the impurities from this sample before analysis, and these figures are therefore only roughly approximate.*

The four samples all gave similar results when tested with the ordinary solvents. They were not completely soluble in alcohol, ether, chloroform, benzene, or turpentine oil, and practically insoluble in a mixture of benzene and turpentine oil, but were partially soluble in mixtures of alcohol and ether, alcohol and benzene, or alcohol and turpentine oil.

On "melting" for 1½ hours all four resins became soluble in turpentine oil. The loss of weight on "melting" was approximately as follows:

Sample.	Loss in weight. *Per cent.*
No. 6	14
No. 7	16
No. 8	30
No. 9	21

Varnish trials were made with the "melted" copals, with the following results:

Sample.	Colour of solution of "melted" copal in turpentine oil.	Characters of varnish on wood.
No. 6.	Pale brown.	Almost colourless, hard and glossy.
No. 7.	A rather darker brown than No. 1.	Do.
No. 8.	Very dark brown, with much black deposit.	Pale yellowish-brown.
No. 9.	Dark brown with some dark deposit.	Similar to No. 8, but paler.

The samples were submitted to a firm of brokers, who valued them as follows:

Sample.	Price per cwt. *ex* wharf, London (October 1912).
No. 6	About £5
No. 7	" 85*s*.
No. 8	" 25*s*.
No. 9	" 50*s*.

The brokers added that there is a good demand for this class of resin in London.

The results of this investigation show that the "Mgeji" copal is of good quality, and that it will be readily saleable on the London market if it is cleaned and graded into the qualities represented by these samples before being exported.

COHUNE NUTS FROM BRITISH HONDURAS

Cohune nuts are derived from the cohune palm (*Attalea Cohune*), a native of British Honduras, where it is said to occur over an area of nearly 2,000,000 acres, or two-fifths of the total area of the colony. It is the characteristic plant of the "cohune ridges," a term applied to the low-lying lands bordering river valleys, or occupying extensive tracts or basins, as in the west and south, or at the heads of some of the rivers.

The nuts are borne in large bunches, and each tree is said to yield 1,000 nuts per annum (*Colonial Reports, Annual*, No. 73, *Report on British Honduras for* 1891 [Cd. 6857-23], p. 21). This estimate, however, is probably too low, and in one case brought to the notice of the Imperial Institute the yield of nuts per tree was 2 cwt., *i.e.* about 2,000 nuts. The kernels are rich in oil; but so far they have not been utilised on a commercial scale, chiefly owing to the difficulty of cracking the very hard shells which surround them. Several machines have been devised for this purpose, and certain of these are now under trial in British Honduras.

The oil yielded by the kernels was examined at the Imperial Institute some years ago, and the results pub-

lished in this BULLETIN (1903, **1**, 25). Since that date a number of samples of cohune fruits and kernels have been received from British Honduras, and the results of their examination are given in the succeeding pages.

A sample of cohune kernels, measuring about $1\frac{1}{4}$ to $1\frac{1}{2}$ in. in length, and $\frac{3}{4}$ to 1 in. in diameter, was received in April 1912. Scarcely any of the kernels were quite undamaged, and many of them were badly damaged. The sample yielded 71·8 per cent. of solid white fat, resembling coconut oil in appearance. As this yield was considerably more than that obtained from the earlier sample, further specimens were asked for in order that the average yield of fat might be determined.

In response to this request three samples of fruits and two of kernels, stated to have been obtained from palms on the Belize River, were forwarded from British Honduras in September 1912. These samples were as follows:

(1) Large brown fruits.—These measured about $2\frac{1}{2}$ to $2\frac{3}{4}$ in. in length, and about $1\frac{1}{2}$ to 2 in. in diameter; they were rounded at the base and pointed at the apex. The papery, leaf-like bracts had in most cases become detached from the bases of the fruits in transit.

The fruits had a tough outer fibrous layer enclosing the nut; this outer layer was about $\frac{1}{8}$ in. thick, and contained a small proportion of fat. The nuts, which measured 2 to $2\frac{1}{4}$ in. in length and about $1\frac{1}{2}$ in. in diameter, had a hard, woody shell, about $\frac{3}{16}$ in. thick and extremely difficult to crack, enclosing an oily kernel; occasionally two kernels were present. The kernels, which were about 1 to $1\frac{1}{4}$ in. long and $\frac{5}{8}$ in. in diameter, resembled ordinary palm kernels in general appearance, but were of a more elongated shape. The average weight of an entire fruit was about 50 grams.

(2) Small fruits resembling those of sample 1, but without bracts. The average weight of a single fruit was 45 grams.

(3) Fruits of a rather darker colour, more rounded in shape, and slightly smaller than those of sample 1. The average weight of a single fruit was 48 grams.

(4) Whole kernels.—These resembled those extracted from the fruits of samples 1, 2, and 3. A fair proportion

of broken kernels was present. The average weight of a kernel was 5·2 grams.

(5) Broken kernels.

The fruits of samples 1, 2, and 3 were found to have the following composition:

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Outer fibrous layer	33·2	15·1	22·6
Nut: Shell	58·0	71·3	66·5
Nut: Kernel	8·6	13·6	10·9

The percentage of kernel in the fruits therefore varied considerably in the three samples.

Outer fibrous layer.—The percentages of moisture and fat present in the outer fibrous layer of the fruits were determined with the following results:

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Moisture	9·6	8·4	10·2
Fat	16·9	20·6	9·3

It will be seen that the percentage of fat in the outer layer of the fruits of sample No. 3 was much less than the corresponding figures for samples Nos. 1 and 2.

The fat obtained in all three cases had a dark greenish colour which was almost completely removed by treatment with animal charcoal, and the fat was then of a pale greenish-yellow tint. An examination of the fat obtained from the fibrous layers in samples 1 and 2 and decolorised with animal charcoal gave the following results, compared with the range of the principal constants recorded for commercial palm oil:

	Sample 1.	Sample 2.	Commercial palm oil.
Specific gravity at $\frac{100° C.}{15·5° C.}$	0·848	0·855	0·9209 to 0·9245
Acid value[1]	162·0	121·3	—
Saponification value[1]	197·4	203·1	196·3 to 205·5
Iodine value . *per cent.*	75·1	65·4	53 to 57·4
Titer test[2]	31·0° C.	—	35·8° C. to 46·4° C. (mostly 44·5° C. to 45° C.)
Hehner value[3]	97·0	—	94·2 to 97
Reichert-Meissl value[4]	1·65	—	0·86 to 1·87
Unsaponifiable matter, *per cent.*	0·95	—	—

[1] *Milligrams of potash for 1 gram of fat.* [2] *Solidifying point of fatty acids.*

[3] *Percentage of insoluble fatty acids and unsaponifiable matter.*

[4] *Cubic centimetres of decinormal alkali required to neutralise the soluble volatile acid from 5 grams of fat.*

Owing to the bulky and fibrous nature of the outer layer of the nuts, the fat could probably not be obtained by expression, but would have to be extracted by means of solvents; and this process would most likely be unremunerative, especially as the residual fibre would be of little or no value.

Kernels.—The kernels yielded a solid, white, crystalline fat, resembling coconut oil in appearance and smell. The percentages of fat and moisture found in the kernels from the samples of fruits Nos. 1, 2, and 3, and in the samples of kernels Nos. 4 and 5, are given in the following table:

	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*	No. 4. *Per cent.*	No. 5. *Per cent.*
Moisture . . .	4·6	4·3	4·2	4·2	4·9
Fat	67·7	68·4	71·6	68·5	65·4

An examination of the fats obtained from these five samples of kernels gave the following results:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity at $\frac{100^\circ \text{ C.}}{15{\cdot}5^\circ \text{C.}}$.	0·870	0·871	0·871	0·868	0·870
Acid value [1]	3·5	13·1	1·2	20·4	12·3
Saponification value [1] . .	255·0	256·5	256·5	252·4	252·4
Iodine value . . *per cent.*	13·6	13·7	11·4	13·7	11·0
Titer test [1]	19·8° C.	21·0° C.	20·2° C.	19·7° C.	—
Hehner value [1]	—	—	—	87·7	—
Reichert-Meissl value [1] . .	6·8	8·3	8·2	7·1	—
Polenske value [2]	—	15·4	—	12·5	—
Unsaponifiable matter, *per cent.*	0·24	0·28	0·23	0·28	—

[1] *For the meaning of these terms see p. 228.*

[2] *Cubic centimetres of decinormal alkali required to neutralise insoluble volatile acid from 5 grams of fat.*

For the purpose of comparison a table showing the range of the principal constants of coconut oil and palm-kernel oil is given below:

	Coconut oil from copra.	Palm-kernel oil.
Specific gravity at $\frac{100^\circ \text{ C.}}{15{\cdot}5^\circ \text{C.}}$.	0·874	0·873
Iodine value . *per cent.*	8·0 to 10·0	10·3 to 17·5
Saponification value . .	246 to 268	242·4 to 254·8
Titer test	21·2° to 25·2° C.	20·0° to 25·5° C.
Hehner value . . .	82·4 to 90·5	91·1
Reichert-Meissl value . .	6·65 to 7·5	5·0 to 6·8
Polenske value . . .	18·0	—
Yield of oil from kernels .	64·5 to 74·7	46·7 to 52·5

The foregoing tables indicate that cohune kernel fat resembles very closely both coconut oil and palm-kernel oil, but is generally of somewhat softer consistency.

As already mentioned, the fibrous layer of the cohune fruit is not likely to be of value under present conditions for the fat it contains. If, however, at some future time plant for the extraction of fat from cohune kernels by solvents were installed in British Honduras, the question of recovering the fat from the fibrous layer of the fruit would be worth consideration.

The cohune kernels yield about the same percentage of fat as copra, and rather more than palm kernels. If shipped to Europe in commercial quantities and in good condition, they should therefore realise prices approximating to those of copra. The present prices of copra in the United Kingdom are approximately from £29 2*s.* 6*d.* to £30 15*s.* per ton (April 1913).

The cohune kernel fat should be worth about the same price as palm-kernel oil or coconut oil, the present values of which in the United Kingdom are as follows: coconut oil from £43 5*s.* to £50 10*s.* per ton, and palm-kernel oil about £42 15*s.* per ton (April 1913). It is not possible, however, to give a definite commercial valuation of cohune kernel fat until it has been submitted to technical trial on a large scale.

SOME NEW OR LITTLE-KNOWN LEGUMINOUS FEEDING-STUFFS

Various beans and other leguminous feeding-stuffs are already cultivated in most of the British Colonies and in India, but the importance of encouraging the cultivation of such crops in tropical countries cannot be too much insisted on. Leguminous plants, as is well known, are able to utilise atmospheric nitrogen, owing to the presence of certain bacteria contained in nodules on their roots. If the vegetative parts of these plants are ploughed in after the crop has been gathered, the soil is not only improved in

physical properties but is enriched by the nitrogenous material present in the plant.

There is a large and regular market in the United Kingdom for white or cream-coloured beans which are usually sold as "white haricot" beans for human food. These beans must be shipped in good condition, clean, and free from extraneous matter and foreign beans. At present the supplies are obtained chiefly from India, Madagascar, Roumania, Germany, and Austria-Hungary. The imports of beans of this class into the United Kingdom during 1909, 1910, and 1911 were as follows:

		1909.	1910.	1911.
Quantity .	. *cwt.*	358,905	284,733	353,780
Value .	. £	213,872	177,837	257,627

There is also a large demand for coloured beans in the United Kingdom for feeding cattle, the supplies being chiefly obtained at present from India, China, Asia Minor, Egypt, and Morocco. The imports of these beans into the United Kingdom during 1909, 1910, and 1911 were as follows:

		1909.	1910.	1911.
Quantity .	. *cwt.*	2,171,230	849,082	1,029,101
Value .	. £	757,600	311,676	375,333

In addition large quantities of "dhol" or "dhall," and "gram," are imported into the United Kingdom as feeding-stuffs, almost the whole supply being obtained from India. The imports of these during 1909, 1910, and 1911 were as follows:

		1909.	1910.	1911.
Quantity .	. *cwt.*	186,310	870,293	1,112,493
Value .	. £	63,085	255,279	325,361

The results of examination at the Imperial Institute of a number of leguminous feeding-stuffs have already been published in this BULLETIN, *e.g.* beans from the East Africa Protectorate (1907, **5**, 238; 1910, **8**, 252), from Southern Nigeria (1912, **10**, 393), from Hong Kong (1912, **10**, 235); Bambarra ground-nuts (*Voandzeia subterranea*) from Northern Nigeria (1909, **7**, 151); pigeon peas from Sierra

Leone (1910, **8**, 405); and Florida beans from Nyasaland (1912, **10**, 129). In the present article samples of beans and similar products from the Sudan, Nyasaland, Northern Nigeria, Ceylon, St. Vincent, and British Honduras are dealt with.

For the purpose of comparison the following analyses of well-known beans recorded by Church in *Food Grains of India* are quoted :

	Haricot beans, *Phaseolus vulgaris.*	Mung beans, *Phaseolus Mungo* (unhusked).	Cow peas, *Vigna Catjang* (*V. sinensis*) (unhusked).	Lablab beans, *Dolichos Lablab* (unhusked).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	14·0	10·1	12·7	12·1
Crude proteins	23·0	22·7	23·1	22·4
Fat	2·3	2·2	1·1	1·4
Starch, etc.	52·3	55·8	55·3	54·2
Fibre	5·5	4·8	4·2	6·5
Ash	2·9	4·4	3·6	3·4
Nutrient ratio	1 : 2·5	1 : 2·7	1 : 2·5	1 : 2·5

	Horse gram, *Dolichos biflorus* (unhusked).	Pigeon peas, *Cajanus indicus* (unhusked).	Lentils, *Lens esculenta* (unhusked).	Peas, *Pisum sativum* (unhusked).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	11·0	11·4	11·7	12·5
Crude proteins	22·5	20·3	24·9	23·6
Fat	1·9	1·4	1·5	1·3
Starch, etc.	56·0	56·4	56·0	54·5
Fibre	5·4	7·1	3·6	5·7
Ash	3·2	3·4	2·3	2·4
Nutrient ratio	1 : 2·7	1 : 3·0	1 : 2·5	1 : 2·4

Beans from the Sudan

The samples received from the Sudan included a series of five native beans and a sample of *Vicia Faba* beans produced in the course of a cultivation experiment. Herbarium specimens of seven beans were also received, and these have been identified at the Royal Gardens, Kew, as follows :

1. Lubia Koshari—*Phaseolus Mungo*, Linn.
2. Lubia Hanatir—*Vigna sinensis*, Endl., ? *forma spontanea.*
3. Lubia Helu or Musran el Balad Baida—*Vigna sinensis*, Endl. (= *V. Catjang*).

4. Lubia Helu or Musran Balad Safra—*V. sinensis*, Endl. (= *V. Catjang*).

5. Fasoulia Baida—*Phaseolus vulgaris*, Linn.

6. Fasoulia Soda—*P. vulgaris*, Linn.

7. Lubia Afin—*Dolichos Lablab*, Linn.

The beans were examined with the following results:

"*Lubia Helu*" (Vigna sinensis).—These were cream-coloured beans with a black ring round the hilum; most of them measured about 1 cm. in length and slightly less in width, but a fair proportion of smaller beans was also present. They had a slightly wrinkled testa and a firm, pale-coloured interior.

"*Fasoulia Baida*" (Phaseolus vulgaris).—This sample consisted of pale cream-coloured, kidney-shaped beans, varying in length from 1 to 1·5 cm., and about 0·5 cm. broad. They had a thin, brittle testa, and a hard, cream-coloured interior.

"*Lubia Afin*" (Dolichos Lablab).—These beans were of flattened, oval shape, about 1½ cm. long, and 0·4 cm. broad, and of a mottled, black to purplish-brown colour. They had a long, prominent, white hilum, a thin testa, and a very hard, cream-coloured interior.

"*Ads Sudani*" (Cajanus indicus).—These were small, nearly round, reddish-brown beans, 0·5 cm. in diameter, having a thin, brittle testa, and a hard, yellow interior.

"*Lubia Koshari*" (Phaseolus Mungo).—This sample consisted of small, nearly cylindrical beans, 0·3 cm. in length and a little less in diameter, and of a dull green colour. They had a thin testa, and a firm yellow interior.

The beans were all plump and in good condition, but most of the samples showed slight traces of insect attack.

The samples were mostly rather dirty, and in some cases contained a small amount of stones, foreign seed, or other impurity. The "Lubia Helu" and "Ads Sudani" beans especially would have been improved by cleaning.

The samples were cleaned and submitted to chemical analysis, with the results shown in the following table, which also includes the commercial valuations of the samples.

	Lubia Helu.	Fasoulia Baida.	Lubia Afin.	Ads Sudani.	Lubia Koshari.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	7·95	7·58	7·40	7·49	8·02
Crude proteins	20·61	23·57	23·53	20·11	27·00
Consisting of:					
True proteins	18·53	20·78	22·70	17·16	25·69
Other nitrogenous substances	2·08	2·79	0·83	2·95	1·31
Fat	1·63	1·63	1·05	1·66	1·20
Starch, etc.	64·07	59·12	56·28	60·58	56·31
Fibre	2·76	3·75	7·95	6·21	3·83
Ash	2·98	4·35	3·79	3·95	3·64
Nutrient ratio[1]	1 : 3·29	1 : 2·67	1 : 2·49	1 : 3·20	1 : 2·19
Food units[2]	119·7	122·1	127·7	115·0	126·8
Value, per ton, in London (September 1912).	£8 10s.	£10 10s.	£5 10s. to £6 10s. for mixing with other varieties for feeding purposes.		

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

None of the samples contained cyanogenetic glucosides.

From a comparison of the analyses of well-known beans given on p. 232 it will be seen that the present samples from the Sudan compare favourably in composition with the ordinary leguminous seeds of commerce.

Vicia Faba Beans.—This sample, as already mentioned, was the result of experimental cultivation.

The usual method of growing beans in the Sudan is to sow the seed on land previously irrigated, and to plough it in as soon as the surface of the ground is sufficiently dry to allow of cultivation, and irrigating the land subsequently by flooding the surface. As somewhat poor results had always been obtained at the Central Experimental Farm, Khartoum North, from beans grown in this way, an experiment was carried out there in 1911–12 in growing the crop on ridges manured with farmyard manure. A plot of land one feddan (1·038 acre) in area was ridged, after ploughing and harrowing, and manure spread between the ridges, which were about 3 ft. apart. The latter were then split by the ridging plough, to cover the manure. Immediately after the manuring and ridging were completed the land was irrigated, and when sufficiently dry the ridges were harrowed down in order to conserve the soil moisture. About four weeks later

(November 9) the ridges were re-made, the seeds sown along their crests, and a second irrigation given at once. The seed was sown at the rate of about 2½ bushels per acre, but better results would probably have been obtained by lighter sowing. Little cultivation was necessary, but six further waterings were given during the growth of the plants. The crop was harvested on March 1, and when threshed yielded 1,849 rottles of beans, equivalent to 1,772 lb. per acre, as well as 182 rottles (180 lb.) of peas, which had been grown amongst them. The total cost of producing the crop was about £3 7s.

The beans received at the Imperial Institute were of cream to pinkish-cream colour, 1¼ cm. long and ¾ cm. broad, with a brittle testa, and a very hard, pale yellow interior. The beans showed no signs of having been attacked by insects, and the sample was very clean, and practically free from extraneous matter.

The results of chemical analysis were as follows:

	Per cent.
Moisture	8·06
Proteins	31·22
Consisting of:	
Crude proteins	26·56
Other nitrogenous substances	4·66
Fat	1·47
Starch, etc.	50·28
Fibre	5·85
Ash	3·12
Nutrient ratio	1 : 1·72
Food units	132·0

These beans contained no cyanogenetic glucosides, and had about the average composition of *V. Faba* beans. They were submitted to a firm of merchants, who valued them at about £6 15s. per ton in London (September 1912).

Kerstingiella geocarpa Seeds from Northern Nigeria

K. geocarpa, Harms (*Voandzeia Poissonii*, Chev.) is a prostrate herb cultivated in Dahomey and in Togoland for the sake of its seeds, which are used as food by the natives. Mr. Lamb, Director of Agriculture, Northern Nigeria, states that he has seen the plant under cultivation in that country on two occasions only, both in the neigh-

bourhood of Bida, Nupe Province, where it is known as "Eyeya," or "Ezokin," and that it appears to be very rarely cultivated, and not generally known. The plant resembles the Bambarra ground-nut (*V. subterranea*) in many respects, and the fruits, which usually contain one or two, or less frequently three, seeds, mature under the surface of the soil.

A sample of the pods found growing near Bida was received for examination in December 1912. The pods were constricted in the middle, and each consisted of a buff-coloured, paper-like husk containing two kidney-shaped seeds separated by a septum. The seeds, which measured approximately ½ in. by $\frac{5}{16}$ in., had a pinkish-yellow to brown skin and were firm and cream-coloured internally. The sample was dry and clean except for a little red earth.

The husks formed 12 per cent. of the sample. The seeds, freed from the husks, were examined with the following results, to which are added the results of analysis of a sample of a white variety of the seeds from Dahomey, recorded by Chevalier (*Compt. Rend.*, 1910, **151**, 1375).

	Present sample. *Per cent.*	White variety from Dahomey. *Per cent.*
Moisture	9·90	10·40
Crude proteins	18·04	21·40
Consisting of:		
True proteins	15·31	—
Other nitrogenous substances	2·73	—
Fat	2·15	1·90
Starch, etc.	63·12	48·90
Fibre	3·96	12·70
Ash	2·83	4·30
Nutrient ratio	1:3·77	—
Food units	113·59	—

The seeds contained no alkaloids or cyanogenetic glucosides. The results of analysis of the present sample of *K. geocarpa* seeds, and the figures recorded for the white variety from Dahomey, indicate that the seeds have a fairly high nutritive value.

If the yield of seeds is satisfactory, *K. geocarpa* would probably be a useful leguminous plant for extended cultivation in Northern Nigeria.

Pigeon Peas from Northern Nigeria

A sample of pigeon peas (*Cajanus indicus*) from Northern Nigeria was received in 1909. It consisted of small, flattened beans, varying in colour from pale brown to pale dove-grey, and somewhat smaller than ordinary peas. The skin was generally smooth, but often wrinkled. The beans were hard, and internally were white or yellow. The hilum was well marked and white, with a characteristic brown spot at one end. A few of the beans were weevilled.

The sample was examined chemically, with the following results:

	Per cent.
Moisture	11·72
Crude proteins	18·40
Fat	1·42
Starch, etc.	57·12
Fibre	8·06
Ash	3·28
Nutrient ratio	1 : 3·27
Food units	106·7

The beans were of satisfactory composition and were suitable for use as a feeding-stuff. They would be worth about £6 5*s.* per ton in this country.

Velvet Beans from Nyasaland and St. Vincent

Samples of black velvet beans have been received recently from St. Vincent and Nyasaland, and a sample of white velvet beans from the latter country has also been examined.

Black Velvet Beans (Stizolobium aterrimum = Mucuna aterrima).—This bean is grown largely in St. Vincent as a cover crop, and it was thought that the large quantity of seed which is produced there might be utilised as a feeding-stuff, if crushed or finely ground, provided that it contained no harmful substances. In order to determine the latter point a sample of the seeds was forwarded to the Imperial Institute for examination in November 1912. The plant is also grown in Nyasaland as a green manure, and a sample of the seeds was received from that country in July 1912.

The sample from St. Vincent consisted of beans of an oval shape, about $\frac{5}{8}$ in. long, $\frac{7}{16}$ in. wide, and $\frac{1}{4}$ in. thick.

The beans had a brittle, shiny black testa, and a hard, straw-coloured interior. In a number of cases they were slightly soft and discoloured internally, owing to their not being completely dry. The taste was faintly bitter.

The beans were plump and free from insect attack, and the sample was generally clean and free from extraneous matter.

The Nyasaland sample was very similar to the preceding, and may be described in similar terms.

The two samples were analysed with the following results:

	Sample from St. Vincent. *Per cent.*	Sample from Nyasaland. *Per cent.*
Moisture	13·8	9·56
Crude proteins	25·8	25·85
Consisting of:		
True proteins	22·5	21·80
Other nitrogenous substances	3·3	4·05
Fat	3·5	3·68
Starch, etc.	48·8	50·64
Fibre	4·9	7·28
Ash	3·2	2·99
Nutrient ratio	1 : 2·2	1 : 2·3
Food units	122·1	124·5

The beans contained no alkaloids or cyanogenetic glucosides.

The beans were submitted to a firm of merchants in London, who valued them at from £5 10*s.* to £7 per ton c.i.f. United Kingdom ports (February 1913). The firm added that these prices represent the value of the beans as a feeding-stuff for animals, as it would hardly be possible to find a market for them in the United Kingdom for human consumption.

There seems to be no doubt that these beans could be safely used as a feeding-stuff for cattle, since they are already so employed in Mauritius (see *Bulletin* No. 24 *de la Station Agronomique de Maurice*, p. 55, 1910). On account, however, of the high nutrient ratio of the beans, it is considered advisable to dilute them with other feeding-stuffs which are not so rich in proteins.

White Velvet Beans (Stizolobium niveum = Mucuna nivea = M. Lyonii).—This sample was received from Nyasaland

along with the sample of black velvet beans. It consisted of flat beans of a rounded rectangular shape, with greyish cream-coloured skin and hard brownish-grey cotyledons. The beans were on the average $\frac{5}{8}$ in. long, $\frac{3}{8}$ to $\frac{1}{2}$ in. broad, and $\frac{1}{4}$ in. thick. They were plump, clean, in good condition, showed no evidence of insect attack, and were free from extraneous matter.

The results of chemical examination were as follows:

	Per cent.
Moisture	9·70
Crude proteins	25·13
Consisting of:	
True proteins	21·25
Other nitrogenous substances	3·88
Fat	3·34
Starch, etc.	50·93
Fibre	7·77
Ash	3·13
Nutrient ratio	1 : 2·3
Food units	122·1

The beans contained no alkaloids or cyanogenetic glucosides. They were submitted to a firm of merchants in London who valued them at the same price as the black velvet beans as a feeding-stuff for animals.

It would hardly be possible to find a market for these beans in the United Kingdom for human consumption. It has, however, been stated that the young fresh legumes, after the removal of the velvety skin, form an excellent table vegetable, and that the fully grown beans are but little inferior to the large garden beans of Europe.

There does not appear to be any definite evidence of the employment of these seeds as cattle food, but the above statement with reference to the use of the legumes as a vegetable, and the fact that the seeds are free from alkaloids and cyanogenetic glucosides, render it probable that they would be a safe and useful feeding-stuff. Owing, however, to their high nutrient ratio it would be advisable to dilute them with other feeding-stuffs less rich in proteins.

LENTILS (*LENS ESCULENTA*) FROM NYASALAND

A sample of lentils grown experimentally in Nyasaland from Egyptian seed consisted of small, fairly plump seeds,

$\frac{3}{8}$ in. in diameter and $\frac{3}{16}$ in. thick, in good condition, and showing no signs of insect attack. The skins of the seeds were of a uniform brown colour, but the interior was in some cases red and in other cases yellow.

The sample contained a small amount of extraneous matter, chiefly earth.

It was submitted to a firm of merchants in London, who reported that it apparently consisted of mixed red and yellow lentils, and would therefore only be worth from £6 to £7 per ton in the United Kingdom (February 1913); they added that if the lentils were all of the red variety they would be worth from £8 to £9 per ton.

Chick Peas (*Cicer arietinum*) from Nyasaland

This sample of chick peas was also grown experimentally in Nyasaland from Egyptian seed. It consisted of small, rounded peas, averaging $\frac{1}{4}$ in. in diameter, with a dull and somewhat uneven surface. The majority of the peas were of a pale buff colour, and had a thin translucent skin and a yellow interior. A number, however, had an earthy-brown skin.

The sample had been slightly attacked by insects, and contained a small amount of extraneous matter. The sound peas were clean and in good condition.

The peas were analysed with the following results, compared with previous analyses of chick peas:

	Present sample.	Figures recorded by Church.	Figures recorded by Koloniaal Museum, Haarlem. (1)	Figures recorded by Koloniaal Museum, Haarlem. (2)
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	8·78	11·5	11·36	14·81
Crude proteins	22·80	21·7	18·00	18·62
Consisting of:				
True proteins	20·44	—	—	—
Other nitrogenous substances	2·36	—	—	—
Fat	4·87	4·2	8·14	5·25
Starch, etc.	57·12	59·0	57·48	53·60
Fibre	3·54	1·0	2·20	4·47
Ash	2·89	2·6	2·82	3·25

The nutrient ratio of the present sample was 1 : 3·0, and

the food units 126·3. The peas contained no alkaloids or cyanogenetic glucosides.

The sample was submitted to a firm of merchants in London, who reported that it consisted of mixed white and brown peas, and would therefore only be worth the same price as Karachi gram, viz. about £6 10*s.* per ton in the United Kingdom (February 1913). They added that the white chick peas, if marketed alone, would probably be worth slightly more, but that they were too small to realise as good a price as white Morocco chick peas.

DHALL (*CAJANUS* SP.) FROM CEYLON

A sample of dhall (*Cajanus* sp.) was received from Ceylon in May 1911. It consisted of small, rounded, rather flattened seeds, light yellowish-brown to purplish-brown in colour, dry and fairly sound; 5 per cent. of those examined were damaged by weevils.

The sample was fairly free from dirt, only a small amount of husks and other débris being present.

The seeds were submitted to chemical analysis with the following results:

	Per cent.
Moisture	10·64
Crude proteins	20·11
Consisting of:	
True proteins	19·87
Other nitrogenous substances	0·24
Fat	1·10
Starch, etc.	57·88
Fibre	6·9
Ash	3·37
Nutrient ratio	1 : 3·0
Food units	110·9

The seeds contained no alkaloid, saponin, or cyanogenetic glucoside.

The dhall was submitted to brokers, who considered that it would be worth about £6 10*s.* per ton in London (October 1911).

The results of the analysis of this sample agree fairly well with the figures previously recorded for dhall.

"Sword Beans" (*Canavalia* sp.) from British Honduras

A sample of these beans from British Honduras, received in May 1910, consisted of large white beans, of fairly uniform size, and showing a characteristic large, oval, brownish-black hilum. The beans were rather soft, and of pale yellowish colour internally. Most of the beans were in very good condition, but a few were rather shrivelled.

The results of chemical examination were as follows:

	Per cent.
Moisture	14·4
Crude proteins	25·0
Fat	2·7
Starch, etc.	48·4
Fibre	6·8
Ash	2·7
Nutrient ratio	1 : 2·2
Food units	117·6

The beans did not contain any alkaloids or cyanogenetic glucosides.

The composition of these beans is quite similar to that of the white haricot beans largely imported into the United Kingdom for use as a vegetable (see p. 232).

The beans were submitted to brokers, who reported that their value could not be correctly ascertained except by actual sale or the distribution of samples among buyers for cooking trials. The brown hilum is likely to be an objection at first, but the brokers considered that if this prejudice were overcome, a good price, possibly 16*s.* per cwt., could be obtained for the beans.

The brokers suggested that 2 or 3 cwt. of these "sword beans" should be sent for distribution to buyers, or that a trial shipment of say 10 tons should be forwarded for sale in London, in order that a definite idea of their value may be obtained.

The beans did not contain any alkaloids or cyanogenetic glucosides, but it may be mentioned that in the *Rapport Annuel de la Station Agronomique de Maurice* for 1909 it is stated that "sword beans" (*Canavalia ensiformis*) are looked upon with suspicion in that colony as being poisonous. The report adds, however, that the beans

have frequently been eaten, and that no actual case of poisoning by them has been recorded in the island. "Sword beans" also appear to be regularly used as a vegetable in the West Indies, and are not there regarded with any suspicion.

MINERALS FROM THE FEDERATED MALAY STATES

In the following pages an account is given of the results of examination of a number of concentrates and other minerals from the Federated Malay States received at the Imperial Institute in recent years. Previous articles and notes on minerals from the Federated Malay States, published in this Bulletin, have dealt with corundum (1904, **2**, 229) monazite (1906, **4**, 301), tin ores (1908, **6**, 155), "amang" (1911, **9**, 99), strüverite (1911, **9**, 354), and sub-bituminous coal (1912, **10**, 623).

Cerussite Concentrate from Ipoh, Perak

This material was a fine-grained concentrate and consisted chiefly of ferruginous cerussite, together with some tinstone and quartz and small quantities of zircon, tourmaline, ilmenite, pyrite, and other minerals. It was found to contain 41·57 per cent. of lead, 10·99 per cent. of tin, and 2·819 oz. of silver per ton of 2,240 lb.

The concentrate was submitted to a firm of smelters, who conducted technical trials with the material and reported on its value in the following terms:

A cerussite concentrate similar to this sample, containing approximately 42 per cent. of lead and 11 per cent. of tin, would be worth at the present time £12 10s. per ton, delivered Bristol (February 1913).

Tungsten Ore from Kinta, Perak

This consisted of a black, coarse concentrate.

The results of a physical analysis showed it to have the following percentage mineral composition: ilmenite 53, wolframite 35, tinstone 6, magnetite 1·5, xenotime 1. The

remaining 3·5 per cent. was composed of tourmaline, zircon, rutile, and quartz, with a little monazite and pyrite. It was found by chemical analysis to contain:

		Per cent.
Stannic oxide	SnO_2	5·86
Tungstic oxide	WO_3	26·15
Titanium dioxide	TiO_2	27·50
Yttrium earth oxides	Y_2O_3, etc. . . .	0·56

The results of the analysis show that the commercial value of this concentrate depends upon the wolframite and tinstone present. A combination of hydraulic and electro-magnetic methods of separation would have to be applied in order to obtain these two constituents in a fairly pure state for industrial use. Information regarding the distribution, composition, and methods of concentrating tungsten ores, and the commercial value and utilisation of such ores, is given in this BULLETIN (1909, **7**, 170, 258).

TIN-BEARING SANDS FROM KELANTAN

Four samples of tin-bearing sands from Kelantan were examined with the following results:

No. 1. "*Doubly concentrated River Sands.*"—This consisted largely of zircon and also contained appreciable quantities of tinstone, monazite, and columbite. A little epidote, magnetite, and ilmenite were also present.

The following are the results of a partial analysis of this sand:

		Per cent.
Stannic oxide	SnO_2 . .	18·41
Thoria	ThO_2 . .	0·82
Ceria and associated oxides (including those of the yttrium group)	Ce_2O_3, etc. .	5·15
Columbic oxide	Cb_2O . .	2·8 (Columbic and Tantalic oxides together)
Tantalic oxide	Ta_2O_5 . .	

No. 2. "*Concentrated fine River Sands.*"—The principal minerals contained in this sample were magnetite, ilmenite, monazite, zircon, tinstone, and columbite. Some garnet, epidote, tourmaline, rutile, hornblende, quartz, and gold were also present.

The following are the results of a partial chemical analysis of this sand:

		Per cent.
Stannic oxide	SnO_2 . .	16·52
Thoria	ThO_2 . .	2·10
Ceria and associated oxides (including those of the yttrium group)	Ce_2O_3, etc. .	8·37
Columbic oxide	Cb_2O_5 . .	2·95
Tantalic oxide	Ta_2O_5 . .	
Gold (*see below*)	Au . .	0·185

No. 3. "*Coarse Concentrate.*"—This sample was rich in tinstone; some mispickel (arsenopyrite), pyrite, magnetite, quartz, garnet, and monazite were present, as well as a little columbite and ilmenite.

The following are the results of a partial analysis of this sand:

		Per cent.
Stannic oxide	SnO_2 . .	85·83
Ceria and associated oxides (including those of the yttrium group)	Ce_2O_3, etc. .	1·55
Columbic oxide	Cb_2O_5 . .	1·90
Tantalic oxide	Ta_2O_5 . .	
Gold (*see below*)	Au . .	1·62

No. 4. "*Medium Concentrate.*"—In mineral composition this sample closely resembled No. 3. The results of a partial analysis showed it to contain:

		Per cent.
Stannic oxide	SnO_2 . .	72·5
Ceria and associated oxides (including those of the yttrium group)	Ce_2O_3, etc. .	1·10
Columbic oxide	Cb_2O_5 . .	2·22
Tantalic oxide	Ta_2O_5 . .	
Gold (*see below*)	Au . . .	1·05

No wolframite was present in these concentrates.

The beads of "crude bullion" obtained from samples 2, 3, 4 were mixed together, and on examination the resulting bullion was found to contain 897 parts of fine gold per 1,000, the rest being silver; no platinum was present. The gold in No. 2 was apparently in the free state, but it was doubtful if this was the case in Nos. 3 and 4.

The amounts of columbic and tantalic oxides in the concentrates were comparatively small.

Concentrate from near Kulim, South Kedah

This sample consisted almost wholly of a mixture of ilmenite, monazite, and tinstone, the approximate percentage results obtained by electromagnetic separation

being as follows: Ilmenite (chiefly) 39, monazite (chiefly) 41, tinstone (chiefly) 20.

The concentrate was found to contain:

		Per cent.
Ceria and allied oxides	Ce_2O_3, etc.[1] . .	27·41
Thoria	ThO_2[1] . . .	1·50
Stannic oxide	SnO_2 . . .	16·04

[1] *Equivalent to* 41·3 *per cent. of pure monazite.*

A sample of pure monazite prepared from the concentrate was found on analysis to contain 3·5 per cent. of thoria (ThO_2).

This concentrate would probably not be saleable in its present condition, but it appeared to be too valuable to treat as waste. The best way to deal with it would be to carry out electromagnetic separation in the Federated Malay States. In this way the monazite and tinstone could be obtained separately in a fairly high degree of purity. The tinstone would then be readily saleable. The pure monazite would probably also be saleable, though it appeared to be of low-grade quality.

Manganese Ore from Tambun

This sample was obtained from a tin mine at Tambun, and consisted partly of a soft brown manganiferous earth and partly of hard black lumps of manganese ore. The earthy portion appeared to preponderate, and had broken up to such an extent that the sample consisted largely of dust.

On analysis the following results were obtained:

		Per cent.
Manganese peroxide	MnO_2 . . .	46·2 }[1]
Manganous oxide	MnO . . .	11·45 }
Silica	SiO_2 . . .	13·58
Ferric oxide	Fe_2O_3 . . .	8·73[2]
Alumina	Al_2O_3 . . .	9·27
Lime	CaO . . .	trace
Magnesia	MgO . . .	0·34
Phosphoric anhydride	P_2O_5 . . .	0·25[3]
Sulphuric anhydride	SO_3 . . .	0·21
Organic matter and combined water . .		9·64

[1] *Together equivalent to* 38·16 *per cent. of metallic manganese.*
[2] *Equivalent to* 6·11 *per cent. of metallic iron.*
[3] *Equivalent to* 0·109 *per cent. of phosphorus.*

This ore was of poor quality, being inferior to the general average of third-grade manganese ores on the market, and material in the condition of this sample would not repay shipment from the Federated Malay States. The poor quality was, however, due to the inclusion of the brown earthy material with the lump ore. If the latter could be worked separately or selected, it seems likely that a first-grade manganese ore would be obtained which would find a ready market in this country at about £2 per ton.

Minerals from Kinta, Perak

Three specimens obtained from the Lano Range, and consisting of a limestone conglomerate containing tinstone, and "red" and "white" earths taken from a cave, were examined with the following results:

No. 1. *Conglomerate with Tinstone.*—This specimen was a calcitic conglomerate, consisting chiefly of quartz fragments set in a matrix of calcite; some fine-grained tinstone, tourmaline, and mica were present, and also a little monazite.

A chemical examination of the sample showed that it contained 2·14 per cent. of stannic oxide (tinstone).

Material represented by this sample would be worth working as a tin ore.

No. 2. *Red Earth from a Cave.*—This was a loose ferruginous clay, containing a considerable quantity of grit and sand grains, together with a little tourmaline.

A chemical examination showed that it contained the equivalent of 19·5 per cent. of phosphoric anhydride. It should consequently prove of value for local use as a phosphatic manure, but it was not sufficiently rich for export.

No. 3. *White Earth from a Cave.*—This consisted chiefly of finely divided calcium sulphate, with a small quantity of phosphate (equal to 1·73 per cent. of phosphoric acid).

The material represented by this specimen might be used as a dressing for soil requiring the application of calcium sulphate.

Samples Nos. 2 and 3 contained only small amounts of stannic oxide, whilst rare earths were absent.

IRON ORE FROM CEYLON

A SAMPLE of iron ore obtained from the Kiribatgala Estate, Dela, was received from the Principal Surveyor, Ceylon Mineral Survey, in July 1912. It was stated that the amount of mineral in sight on the surface is considerably over 10,000 tons, and the whole quantity available without excavation is probably 50,000 tons. The ore is favourably situated for exploitation, as it all lies close to several roads and could be easily loaded into carts. A station on the new Pelmadulla Railway will eventually be opened about a mile from the deposits, but at present it would be necessary to transport the mineral by cart or boat to Ratnapura, a distance of ten miles. The sample received for examination consisted of brown hydrated iron ore, which was analysed with the following results:

		Per cent.			*Per cent.*
Ferric oxide	Fe_2O_3	77·99[1]	Magnesia	MgO	0·18
Ferrous oxide	FeO	trace	Silica	SiO_2	4·11
Alumina	Al_2O_3	2·27	Phosphoric anhydride	P_2O_5	1·56
Manganous oxide	MnO	0·81	Sulphuric anhydride	SO_3	0·22
Titanium dioxide	TiO_2	0·11	Loss on ignition	—	12·55
Lime	CaO	nil			

[1] *Equivalent to* 54·59 *per cent. of metallic iron.*

The sample represented a fairly high grade of phosphatic iron ore, which would be suitable for the manufacture of steel by the basic process. It was submitted for valuation to three firms of iron-smelters, who reported as follows:

One firm stated that although the ore could not be used in the Bessemer process it would no doubt be a good ore for the manufacture of "basic pig," which does not command so high a value as a hæmatite iron. They added that it was difficult to give a definite valuation of the sample, as freights are constantly varying and the material would have to compete in the United Kingdom partly against imported ores and partly against ores raised locally. They were of

opinion, however, that the cost of transport would prevent the remunerative export of an ore of this class from Ceylon to Europe. A similar opinion was expressed by the second firm.

The third firm valued the ore at about 15*s.* per ton c.i.f. Middlesbrough or other similar port (March 1913), on a basis of 50 per cent. metallic iron in the mineral as received (not dry), with a scale of 4*d.* per ton per unit of iron above or below 50 per cent. At this rate ore represented by the sample under report would be worth 16*s.* 4*d.* per ton.

ARGENTIFEROUS LEAD ORE FROM SOUTHERN NIGERIA

A NUMBER of occurrences of lead ore have been recorded from Southern Nigeria. Deposits of lead ore found near the Aboyni river and east of Amago Omegga, in the Enyiba district, were examined by the officers of the Mineral Survey of Southern Nigeria in 1906, and three samples of the ore forwarded to the Imperial Institute for examination were found to contain 64·45, 74·65, and 53·00 per cent. of lead and 8·59, 9·05, and 3·95 oz. of silver per ton respectively (*Report on the Results of the Mineral Survey, Southern Nigeria*, 1905–6 [Cd. 4994], p. 21). This district was again visited by the Surveyors in 1908–9 and further deposits were located, the most notable being a lode occurring at Alusi Hills, Ifotta, near Enyiba. The ores from this lode, however, were distinctly poorer in lead and silver than the previous samples (*Rep. Min. Surv., Southern Nigeria*, 1908–9 [Cd. 5901], p. 10). At the end of last year six samples of lead ore from the Ogoja and Abakaliki districts were received for examination. In each case the material consisted of galena; sample No. 1 contained a considerable amount of barytes, the other samples contained ferruginous impurity, and in one case (sample No. 5) small amounts of zinc blende and copper pyrites were present.

The results of examination and valuation of these ores were as follows:

Origin of sample.	Ogoja district.		Abakaliki district.			
	Warankandi.	Wurkum.	Mkpume.	Igwenidor.		
	1.	2.	3.	4.	5.	6.
Lead, . . *per cent.*	32·97	60·71	58·48	53·69	65·14	61·59
Zinc, . . *per cent.*	trace	0·12	0·20	0·16	0·02	0·19
Copper, . *per cent.*	trace	0·18	0·23	0·18	0·19	0·10
Silver, *oz. per ton* of ore	2·6	98·0	73·1	94·6	112·3	73·5
Value, per ton, c.i.f. Swansea, with "soft foreign" lead at £16 10*s.* per ton, and silver at 2*s.* 5*d.* per oz.	£2 16*s.* (£2 10*s.* for the lead and 6*s.* for the silver).	£18 7*s.* (£7 2*s.* for the lead and £11 5*s.* for the silver).	£15 2*s.* (£6 15*s.* for the lead and £8 7*s.* for the silver).	£16 15*s.* (£5 19*s.* for the lead and £10 16*s.* for the silver).	£20 13*s.* (£7 16*s.* for the lead and £12 17*s.* for the silver).	£15 13*s.* (£7 5*s.* for the lead and £8 8*s.* for the silver).

All these samples, with the exception of that from Warankandi, represented valuable silver-lead ores which would be readily saleable in the United Kingdom.

THE SALT INDUSTRY OF TURKS AND CAICOS ISLANDS

The Turks and Caicos Islands are situated about 400 miles north-east of Jamaica, of which colony they constitute a dependency. The chief industry is salt-raking, which has been carried on more or less continuously since 1678, when people from Bermuda visited the islands for that purpose. At the present time there are 231 acres of salt-pond at Grand Turk, 114 at Salt Cay, and 248 at Cockburn Harbour. All the salt produced is obtained by solar evaporation, the average annual production being about 1,750,000 bushels. Most of the product is shipped to the United States as coarse salt for preserving purposes, but a small quantity of "fish" or ground salt is exported to Canada. The total value of the salt exported in 1911 was £19,503, including "fish" salt valued at £4,246. The salt ponds are owned by private holders, who pay a royalty on all salt shipped at the rate of 10 per cent. on the market value, which is at present about 3*d.* to 3½*d.* per bushel of 35 imperial quarts. In recent years there has been a considerable depression in the industry. This was due partly to decreased production owing to the

weather conditions and partly to the fact that the United States are developing a domestic salt industry, and are now able to produce practically all that is required for local consumption, and as a consequence of competition with other salt-producing countries the Turks Island salt had to be disposed of at prices below the cost of production. Attempts have been made by the Legislative Board of the islands to improve the conditions by means of grants-in-aid, firstly to the working proprietors, to rescue them from their more immediate financial difficulties, and secondly to a fund to provide for the more economical working of the ponds, the prevention of waste by exposure to the atmosphere of salt when raked, and the permanent improvement of the common property. Legislation on these lines came into force in 1911, when £1,767 was allotted for relief during the year.

The salt produced in the islands is of excellent quality, and a sample examined at the Imperial Institute in 1906 was of exceptional purity as compared with English, American, and other salts (see this BULLETIN, 1907, **5**, 188). Two further samples were received in 1908 and 1912 respectively, and the results of their examination are of interest as indicating the uniform character of the salt produced over a number of years. The results of analyses of the samples received in 1908 and 1912 are shown in the following table, to which are added the figures obtained from the earlier specimen:

	Specimen received in		
	1906.	1908.	1912.
	Per cent.	*Per cent.*	*Per cent.*
Sodium chloride	99·24	99·42	99·42
Potassium chloride	trace	nil	—
Calcium chloride	0·22	0·09	0·08
Magnesium chloride	—	0·05	0·12
Calcium sulphate	0·02	0·03	0·09
Magnesium sulphate	0·01	—	—
Iodine and bromine	trace	nil	nil
Insoluble matter	0·05	0·06	0·03
Loss on ignition	—	—	0·18
Moisture	0·10	0·15	0·09

SPECIAL REPORT

TEA: ITS CULTIVATION, MANUFACTURE, AND COMMERCE

The following is a report of a series of lectures on "The Economics of the Tea Trade," delivered at the London School of Economics and Political Science during the Lent Term, 1913, by S. E. Chandler, D.Sc., F.L.S., and John McEwan, F.R.G.S.

I.—FOUR LECTURES ON THE CULTIVATION AND MANUFACTURE OF TEA

By S. E. Chandler, D.Sc., F.L.S.

There would appear to be good reason for supposing that tea was first used in China not for the preparation of a beverage, but as a medicine. Subsequently the leaf, prepared by special methods, came to be eaten as a vegetable, as it is in certain parts of Burma and the Shan States at the present day. It was not, however, until the beverage-making qualities of tea were discovered that the regular cultivation of the plant in China became extensive, and that "tea," in the modern sense of the word, came into existence at all. There is definite evidence that tea-drinking was well known in China in the sixth century A.D., and that in 793 the custom was sufficiently widespread to warrant the imposition of a tax for revenue purposes—the first of an endless series of tea duties. Henceforward the use of tea spread rapidly among the Chinese peoples, and, since the introduction of the article to Western countries in the seventeenth century, "China" and "tea" have been inseparably associated. The association remains, but not unimpaired, for the gigantic tea industries of India and Ceylon, which have arisen during the last three-quarters of a century, have succeeded in the virtual ousting of the Chinese product from one of the most important markets in the world. It is, however, commonly stated that, in view of her enormous population of tea-drinkers, China must still remain the chief tea-producing country, in spite of restricted exports. While this may be the case, the statement is made in the complete absence of any statistical evidence, and, as is well known, the tea trade, in recording figures of the world's "production," ignores the quantities consumed in both China and Japan, and refers only to the exports of the great tea-growing countries. The figures (estimated) for the world's "production" of tea for 1912 are as follows:

	lb.		lb.		lb.
India .	295,000,000	China .	112,000,000	Japan .	43,000,000
Ceylon .	193,000,000	Java .	63,000,000	Formosa	25,000,000
		Total	731,000,000 *lb.*		

The distribution of this enormous total to some ten principal tea-consuming countries resulted in an average *per capita* consumption of probably not less than 3 lb. The most recent official returns for different countries refer to 1909 and 1910, when the average consumption was 2·73 lb. per head, but it is probable that the figures are now somewhat higher. The official returns for 1909 or 1910, with certain additions now available, are given below:

	lb.		lb.		lb.
New Zealand .	7·4	Holland . .	2·1	United States .	0·9
Australia . .	6·8	South Africa .	1·2 (est.)	Russia . .	0·9
United Kingdom .	6·4	Denmark (1911)	0·37	Germany .	0·1
Canada . .	4·3	Belgium (1911)	0·22	France . .	0·07
		British Empire (excluding South Africa) . .	6·2 *lb.*		
		Foreign countries (excluding U.S.A.) . .	0·63 ,,		

The most notable feature in the above figures is the pre-eminence of the British people as tea-drinkers: the consumption is no less than ten times that of foreign countries, excluding the United States. In the British figures New Zealand heads the list, which is closed by South Africa. The low average of the latter country results from the presence of a large Dutch and native population consuming but little tea, while the no more than moderate consumption of Canada is no doubt to be attributed to the French-Canadian element and the large number of immigrants from countries where tea-drinking is comparatively rare. Holland heads the list of continental tea-consuming countries, a fact no doubt in part to be explained as a result of her possessing a great tea-producing colony in the Middle East; and it will be recalled that the Dutch were the first to introduce tea into Europe. The Russian figures occasion some surprise. It is commonly supposed that the Russian people are great tea-consumers, but while this is true in regard to the quantity of liquor taken, the amount of tea used in preparing the beverage is comparatively small, except among the upper classes. This fact is to be correlated with the comparative poverty of the great bulk of the population, who are compelled to take their tea greatly diluted, and to use the leaves several times. It is well known to tea-growers that exports of tea to Russia largely depend upon the character of the Russian harvest; good harvests mean relatively high imports, and vice versa. The large population, however, renders the market one of the most important in the trade. In the United States tea is slowly but surely coming into favour, the price of coffee

being a factor in the situation. The American market hitherto has been concerned chiefly with green teas from China, Japan, and Formosa, but the regulations against "faced" green teas, and the excellence of the Ceylon and Indian products, green and black, promise to effect a change in the circumstances of the trade. In Denmark and Belgium, especially the former, tea-drinking has shown a strong tendency to increase: in Belgium there has been a 70 per cent. advance in imports since 1897, when the duty was abolished. France shows little sign of following suit: a large proportion of the tea imported is grown in the French colony of Annam, and is of comparatively poor quality.

The great disparity between the populations of tea-consuming countries, however, places an entirely different aspect upon the situation when imports for home consumption are considered, Russia now standing second in importance, and countries high upon the previous list taking a relatively low place. New Zealand, for example, stands below Germany, a country with an almost negligible consumption per head. The following are approximate figures for 1911, the last year for which complete returns are available:

	lb.		*lb.*
United Kingdom .	295,000,000	Germany . . .	9,000,000
Russia . . .	147,000,000	New Zealand . .	7,000,000
United States .	83,000,000	South Africa . .	7,000,000
Canada (1911–12) .	34,000,000	Belgium (1910) . .	1,600,000
Australia . .	29,000,000	Denmark . . .	1,000,000
Holland (est.) .	12,000,000		

There are few agricultural industries in which there is a greater need for a thorough knowledge of the scientific principles underlying the processes involved than in the growth and manufacture of tea. There are three main problems with which enquiry has been concerned, viz. (1) the question of the true nature of the plant grown; (2) the securing of the maximum yield of the highest-quality leaf with the minimum injury to the plant; (3) the regulation of the processes of manufacture in order that the possibilities of the green leaf may be fully realised; and to these must be added the important practical questions that have in so great measure been solved by the genius of the engineer. None of these lines of enquiry can be usefully prosecuted as a self-contained problem; each will be found, in greater or less degree, to be dependent for its completeness upon the results of investigations into the remaining problems. The more completely this interdependence is recognised and acted upon the greater becomes the practical and scientific value of the results achieved. Of the problems referred to it will be observed that the first is botanical, the second agricultural, and the

third, while at one time suspected of being, in part, biological (bacteriological), has since been found to be in the domain of the chemists, whose work in this direction has accomplished results of remarkable practical importance. No mention of such work would be complete without reference to the researches carried out by Mann and other scientific officers of the Indian Tea Association, and by Bamber in Ceylon; while in Java valuable work has been done by Nanninga and others. So far as the British tea-growing industry is concerned there can be no doubt as to the practical value of the revolution in methods that has taken place during the last forty or fifty years. Whereas in 1873 the average yield of finished tea per acre in Assam was approximately 270 lb., it is now about 500 lb. per acre, the tea, moreover, being of far better quality. An advance of this magnitude cannot be continued indefinitely, but the achievement of such results is evidence of the research that has been carried out by and on behalf of the Indian planters during the last half-century.

Many of the problems confronting the producer of tea are concerned, directly or indirectly, with the need for increased production. This results, in large measure, from economic circumstances, for in most of the great tea-growing countries planters are met with an increasing cost or even actual scarcity of labour, and this in face of a demand for tea that shows no signs of retrogression. In meeting this demand it is often difficult to open up large new areas, if only on account of the labour question, and there would appear to be but one solution of the difficulty, viz. increased productivity of the existing plantations. To effect this there is often a natural temptation to pluck more heavily than is desirable for the well-being of the bushes, and a wiser policy places more reliance upon improved methods of cultivation and the use of manures based upon scientifically conducted experiments.

The Botany of Tea

The tea plant has not escaped a troublesome confusion of nomenclature. Botanists, however, now widely accept the name published by Link in 1822, viz. *Camellia Thea*, Link, which indicates that the tea plant belongs to the *genus* Camellia, well known as containing the familiar "Japanese Camellia" (*C. japonica*), and is of the *species* Thea; while the name further implies that the plant was formerly referred to as a species of the genus Thea, and the names *Thea sinensis*, Linn. (1753), *T. Bohea*, Linn. (1762), *T. viridis*, Linn. (1762), given by Linnæus, in the years indicated, to the plant and its alleged "black" and "green" forms, will be familiar to all acquainted with the literature

of tea. The genus Camellia belongs to the natural order Theaceæ.

As is well known, the plant is cultivated as a low bush, but in its wild state, or if allowed to grow freely, it attains much greater proportions, the Indian plant becoming a small tree resembling certain species of poplar in general habit. The root-system is well developed, presenting a long taproot with strong laterals giving rise to successively finer branches, which finally terminate in the delicate absorbing rootlets. The branches of the stem are, as is well known, profoundly modified by pruning. The elliptical, pointed leaves, which are arranged in an alternate fashion on the shoots, have a leathery texture and a more or less strongly toothed margin. They vary greatly in size according to the race of the plant: in Chinese varieties the length may be only 1–2 in., and the width ½–¾ in., but in certain Indian jats the length reaches as much as 14 in., with a corresponding increase in width. In the bud and very young stages the leaves are covered on the lower surface with a conspicuous, closely appressed down of soft hairs which, during the process of manufacture, assume a pale orange colour and are in large measure responsible for the characteristic colour of the delicate "tip" in certain classes of tea. The handsome white flowers are fragrant, and occur one, two, or three together on short stalks in the axils of the leaves. They are composed of an outer green calyx of five or six leaves, followed by the white petals, from five to nine in number: these two envelopes surround the essential parts of the flower, viz. the male apparatus, consisting of a large number of conspicuous yellow stamens, and, in the centre, the ovary, that gives rise to one, two, or three large seeds in as many compartments when it ripens into the woody "fruit" or capsule. The seeds contain an abundance of a pale yellow, non-drying oil, the commercial utilisation of which has been the subject of repeated consideration.

No small part of the difficulties that arose in connection with the nomenclature of the tea plant are to be attributed to the incorrect understanding that existed for many years as to the relationship between the black and green teas. As is now common knowledge, the differences between these two kinds of tea result entirely from differences in methods of manufacture, and are in no way due to specific distinctions in the plants yielding the green leaf. This fact, however, was not realised in the eighteenth century. Shortly after Linnæus described the tea plant as *Thea sinensis*, Linn., the botanist Hill (1759), on the evidence of specimens supplied to him, described two forms of the plant, viz. *T. Bohea*, Hill, asserted to be the source of *black* tea; and *T. viridis*, Hill, producing *green* tea. Hill's classification was accepted by Linnæus, who pub-

lished the names in the second edition of his famous work, *Species Plantarum* (1762). The heresy thus received official sanction, and flourished for many years; it was not finally stamped out until the botanist Fortune, in 1847, described the manufacture of the two teas from one and the same variety of plant as witnessed by him in China. Even since that date the story has been revived from time to time in the semi-popular literature of the tea industry. It is remarkable that previous to Fortune's definite statements the true state of affairs had been clearly indicated on two widely separate occasions: by Lettsom, in his *Natural History of Tea* (1799), and by a Dutch physician, Bontius, who in 1631 investigated the Japanese tea industry, and reported as to the true relationships of black and green teas. It was thus over 200 years before this elementary fact was thoroughly assimilated.

Botanical questions also played an important part in the action taken by the Indian Government to establish a tea-planting industry during the earlier part of last century. Recognising the possibilities of such an enterprise, they secured, in 1780, seed for planting purposes, and supplies were then, and subsequently, naturally obtained from China, where the plant had been in cultivation for generations. But between 1819 and 1824 a new variety of tea—the famous "Assam Indigenous"—readily distinguishable from the common Chinese type, was discovered wild in India itself, growing in the forests of Assam and Manipur. Much dispute arose as to the relative merits of the Chinese and Indian plants, and it is a matter of surprise that, in the main, the bulk of expert advice was in favour of the Chinese variety. The further development of this question is dealt with below in connection with the modern Indian industry.

The discovery of a wild tea in India led to the view, which finds wide acceptance at the present day, that "the home of the tea plant" is not China, but India. The comparatively recent work of Dr. Krasnoff and others, however, throws much light on this question. During his investigations into the tea industries of Asia on behalf of the Russian government, Krasnoff discovered tea growing perfectly wild in the damp oak forests clothing the mountain slopes of southern Japan; and at about the same time a variety of tea closely resembling the "Assam Indigenous" was found by Dr. Henry growing "absolutely wild" in the virgin forest of Yunan, in Central China, at an altitude of 7,000 ft.; and the same variety was collected by Dr. Faber on Mount Omei in Szechwan.

In summing up this evidence, therefore, it would seem that the original home of the tea plant is not to be sought for in any one country. Krasnoff inclines to the view that the plant is indigenous to the whole monsoon region of eastern Asia—notably the Assam-Yunan area—and that

the various forms of the plant cultivated in different countries have been brought about as a result of adaptations to the varying climatic and cultural conditions to which they have been subjected. But it is pointed out that the differences between the average Indian and Far Eastern stocks are so considerable, that it is doubtful whether they could have been brought about by the causes suggested, and it is highly probable that the stocks arose from two independent, though closely related sources. The discovery of wild forms in both Japan and India confirms Krasnoff's views.

Indian Teas.—It is now generally recognised that the most valuable varieties of the tea plant are those obtained from the north-eastern districts of India. A scientific classification of the Indian teas is therefore a matter of considerable practical importance, and in this direction a great advance was made in 1907, when a paper on the botany of the tea plant was published by Sir George Watt. The paper describes all the varieties (in the lay sense) hitherto discovered in India, and indicates the relative positions of the principal Chinese forms. An important criterion in the classification is the number and character of the veins of the leaves borne on shoots arising from the old wood, and in this connection Watt indicates a practical outcome of the research, since, in referring to Mann's statement that all hybrids should be avoided in planting up an estate, he affirms that this amounts to rejecting "all plants that show from 10 to 14 veins."

The following is a résumé of Watt's classification, in so far as it affects practical questions. The tea plant, *Camellia Thea*, is referable to four *varieties*, of which two, viz. var. *viridis* and var. *Bohea*, are alone of practical importance. The former, in its races "Assam Indigenous" and "Manipur," is widely planted in India, Ceylon, and Java, while the latter yields much of the China tea of commerce.

C. Thea, Link.

A. Variety viridis.

Race 1. *Assam Indigenous*: the most highly prized and abundantly cultivated of all Indian teas; discovered wild in Assam, Manipur, etc.; a large bush or small tree; leaves 4 to 7¾ in. long by 2 to 3 in. broad, of thin texture, with tissue bulging between the veins, and roughened on under-surface; veins, usually 16 on either side of mid-rib; *Sub-races*: Singlo, Bazelona, etc.

Race 2. *Lushai* (Cachar Indigenous, light-leaved Manipur): found wild in Lushai Hills and South Cachar, and cultivated to slight extent only; a somewhat delicate plant; leaves up to 14 in. long and 6 in. broad—the largest of all tea leaves; 20 to 24 lateral veins, with other leaf characters as (1).

Race 3. *Naga Hills*: a small, straggling tree, very little cultivated; leaves 4 to 9 in. long by 2 to 3 in. broad, with 16 to 18 lateral veins.

Race 4. *Manipur*: wild in Manipur, but cultivated "fairly extensively" in Cachar and Assam; leaves 6 to 8 in. long by 2½ to 3½ in. broad, with (usually) 22 lateral veins.

Race 5. *Burma* and *Shan*: grown in countries named; leaves small, and used as a vegetable (see "Letpet tea," p. 283).

Race 6. *Yunan* and *China*: resembling Assam Indigenous in leaf characters; described by Fortune as being grown throughout China south of the Yang-tse-Kiang; found wild by Henry in Yunan and by Faber in Szechwan.

B. Variety Bohea: the Chinese "Bohea Tea" of Fortune and others, and the "Hybrid Tea" of Indian planters. A fairly large, vigorous bush, with smooth, thick leaves of medium size, having 10 to 14 primary veins. This variety is the chief tea plant cultivated in South China, Kuang-tung, and the Fukien Province, and is reported from Japan and Formosa; it is known in India only in the cultivated state. No classification of races is available.

C. Variety stricta: a small, stunted bush with thick, leathery leaves, not more than 2½ in. long by ¾ in. broad; met with in certain districts of India and China; of no commercial value.

D. Variety lasiocalyx: a low, much-branched bush with small, narrow leaves: found cultivated in Malacca and Penang, but of no commercial value; the most tropical of all forms of tea plant.

As regards the Chinese tea plants, it will be seen that, while full information regarding them is not available, two distinct forms may be distinguished: (1) a large-leaved plant of Yunan, closely resembling the best Indian plant; (2) a small-leaved plant of more northern districts. Watt has shown that this fact has long been known, though until recently quite overlooked. He points out that in 1738 du Halde stated that the large-leaved Chinese plant produced a finer tea, and suggests that the original introduction into India of the relatively inferior, small-leaved plant may well have been no mere accident on the part of the Chinese. It is asserted that "in China the finest tea plants are scarcely, if at all, different from the finest Assam races." The manufacture of tea from such Chinese plants, by modern Indian methods and machinery, would be a most interesting experiment.

CULTIVATION

The cultivation and manufacture of tea present a series of problems of great interest from both practical and scientific points of view. Tea is one of the comparatively small number of perennial plants grown for the sake of a leaf-crop. Other examples are "maté" (a "tea" prepared

from the leaves of certain South American hollies); the leaves of a bush, *Erythroxylum Coca*, from which cocaine is prepared; leaves yielding certain rope and cordage fibres; and, in Japan, the mulberry-leaf crop, which in that country plays so important a part in the silk industry. The object of a very large number of agricultural operations is to secure for human use the materials stored up by the plant in the fruits or seeds, for the direct or indirect benefit of the young plants of the next generation—*i.e.* for the species. These materials, together with those making up the body of the plant, in large measure owe their origin to the complex chemical changes that take place in the leaves, which organs are thus of primary physiological importance. The periodical removal of the ripe fruit of such perennial crop plants as coffee and cocoa, or apples and pears, even under the more or less artificial conditions imposed by agricultural practice, probably results in little or no harm to the plant: advantage is taken of a natural phenomenon, for the detachment of the seed from the parent body can alone render possible the performance of its proper functions. In tea culture, however, the fruits or seeds are not the objects sought for: in this case the leaves, and especially the young, vigorous leaves, are required, the fresh shoots ("flushes") being removed every few days. The removal from the plants of the organs intended to supplement or replace, in their vital activities, the mature and old portions of the leaf system must have an important physiological effect on the plant as a whole; and when, in addition, it is recalled that frequent and often drastic pruning is resorted to in order to provide the stimulus for further shoot-production, it will be evident that the cultivated tea plant is subjected to a severe and wholly unnatural treatment, to which a reply will be forthcoming. In the average case, the reply is in the form of a slow but unmistakable decline in vigour, productivity, and quality of the plants, a phenomenon well known to the planters as "deterioration." Differences of opinion exist as to the time when deterioration may be expected to set in, a high authority placing it at between the tenth and twentieth years, but local conditions will naturally affect the question. In Ceylon and Java further special circumstances of climate must also be taken into account. In China, Japan, and the hill-country of northern India the cold season causes a check to vegetative growth, and therefore plucking, and the plants are afforded a valuable rest; but under the more uniform conditions of temperature and moisture prevailing in Ceylon and Java, the tea is in more or less active growth throughout the entire season, and a useful period of recuperation is not readily obtained. In this connection it may well be a matter of significance that more attention has hitherto been

paid in Ceylon to the manurial treatment of tea than in any other tea-producing country.

Strong efforts have been made to combat the deterioration of the tea plant, notably in the scientific work of the Indian Tea Association. Mann has shown the definite value of manuring, proper drainage and careful (but often severe) pruning in postponing the decline, and even of building up, for prolonged periods, deteriorated plantations; but it will be evident that under ordinary circumstances a depreciation is inevitable, though the more scientific the cultural methods adopted, the longer will appreciable deterioration be deferred. Reference must here be made to the fact that the decrease in general vigour resulting from long-continued plucking and pruning will tend to increase the susceptibility of the plant to its numerous enemies, both insect and fungal. In dealing with these pests the tea-planter is at a disadvantage when compared with other agriculturists, for the special nature of the crop militates against his securing in fullest manner to the plants the perfect hygienic "tone" that in other crops is quite compatible with heavy yield.

Climate and Soil.—For the successful cultivation of a crop, primary considerations are those of climate and soil. As regards the former, the great tea-growing countries present very varying circumstances: the hot, steamy climates of Upper Assam, Ceylon, and Java; the cooler conditions in the upland districts of Darjeeling, Kumaon, and Kangra; while in certain tea areas of China and Japan a resting period is brought about by frost, as is also the case in the small but interesting tea district in the Caucasus. Reference to a map will show that tea is grown successfully between a range of no less than 73° of latitude—between 43° N. in the Russian Caucasus and 30° S. in Natal; but McEwan has pointed out that all the important tea-producing regions lie within a relatively restricted area of about 40° of latitude (32° N. and 8° S.) and 60° of longitude (80° and 140 °E.). It is to be remarked, however, that even within these limits there are marked climatic differences, to which are to be attributed the earlier discussions as to the ideal conditions for the crop. With the evidence now available, it would seem that tea requires a warm, subtropical climate rather than the conditions prevailing in the hottest part of the tropics; but it demands an atmosphere rendered more or less continuously moist by a well distributed rainfall of not less than 60 in. per annum, though, as is well known, the best tea districts of Assam and Ceylon have a rainfall greatly in excess of the minimum, the average for the most successful districts of India being over 90 in. per annum. The rainfall requirements of tea are well illustrated in the fact that Para rubber has been largely planted among the tea in the lower

gardens of Ceylon, and this species will not flourish with much less than 80 in. per annum. It is recognised, however, that, so far as India is concerned, the mere figures of the total annual rainfall are an unsafe index of the suitability of an area for tea: far more depends upon the sufficiency of the precipitation during the dry months, February to May inclusive.

As regards temperature, the most satisfactory growth is produced with a daily variation between about 75° F. and 85° F., though the higher temperature is often exceeded. The temperature is closely connected with altitude, which is widely recognised as having a strong influence on the character of the tea. In the Indian areas an interesting comparison may be made between different producing areas, with varying climatic conditions, and the character of the teas produced in them: the comparatively cool hill-districts of northern India, reaching an altitude of several thousand feet, produce teas remarkable for flavour, but not for yield of leaf per acre; Upper Assam and Cachar—a home of the tea plant—with "probably the ideal tea climate," yield heavy crops of teas, commonly held to be the finest in the world; while the lower districts of Sylhet, Chittagong, and Lower Assam, with hotter and drier climates, produce heavy crops of a lower-grade tea. The case of Ceylon is also instructive, the higher altitudes producing teas that are, in general, distinctly superior to those of the low country.

It has been said that tea will grow in almost any soil provided it is well drained, but for the growth of the plant as a commercial crop this statement needs qualification. Physical characters are of first importance: the soil should be well drained, porous, and friable, with a subsoil permanently retaining a satisfactory supply of moisture, and deep enough to allow of the full development of the tap-root and abundant root system. As might be expected, tea is intolerant of clays liable to become "baked" during dry weather, and of poor gravelly soils. In respect of the chemical requirements of tea soils, knowledge is chiefly due to Bamber (Ceylon), Mann (India), and Nanninga (Java). Tea makes special demands upon four constituents, viz. organic matter, nitrogen, phosphoric acid, and potash. The two first named are of great importance in regard to yield of leaf, and in India the best results would appear to be obtained when the non-sandy part of the soil contains 30–35 per cent. of organic matter and about 0·8 per cent. of nitrogen. Other things being equal, the luxuriance of the plants appears to vary directly with the amount of organic matter and nitrogen present, but excess of these constituents reduces the quality of the tea, which yields a weak, watery liquor, lacking in flavour. Exceptional crops, of a relatively low-quality tea, have been

produced in India on certain peaty lands, the bheel soils of Sylhet and Cachar (Surma Valley), and a comparison of these soils with virgin soils of Assam in respect of organic matter and nitrogen is given in the following table (Mann):

	Virgin grass land (Upper Assam).	Virgin forest land (Upper Assam).	Peat bheel soil (Sylhet).	Peat bheel soil (Cachar).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Organic matter, etc. .	6·75	5·75	51·76	40·56
Nitrogen	0·14	0·12	2·37	1·17

The phosphoric acid and potash present in the soil appear to have a close relationship to the development of flavour in the tea. The best-quality teas are made from the youngest leaves and the tip of the growing shoot, and it is significant that both phosphoric acid and potash play an important part in the formation of new plant substance. The presence of these constituents in sufficient quantities is therefore essential for the production of good teas. The teas of Darjeeling are famous for high flavour, and a comparison of the local soils with average soils of Assam in respect of phosphoric acid content is instructive:

Soil.	Available phosphoric acid.	Proportion.
	Per cent.	
Assam (average of five soils)	0·0063	1
Darjeeling (average of three soils) . . .	0·0126	2

In certain particulars the functions of the potash run parallel with those of the phosphoric acid, but in addition it would appear to play an important part in the production of tannin, to which the pungency of the tea is due, and its importance is therefore obvious. Other constituents of the soil, *e.g.* iron and manganese, also play a part, but their action is not fully understood. Lime is said by Mann to be required only in small quantities in tea culture: comment has frequently been made upon the small proportion of this substance in the tea soils of India.

Manures.—The above brief account summarises the more important points in regard to tea soils. It is obvious that the continual removal of a crop from a soil will reduce the quantities of available food substances in the soil, and in the average case, if such substances are removed at a rate greater than that of their replenishment by natural agency, the soil will become relatively impoverished in regard to a particular crop. In the case of a permanent crop like tea, rotation is not feasible, and scientific manur-

ing to supply the deficiencies, or the abandonment of the land for fresh areas, appear to be the only practicable alternatives. In India, especially, the large quantities of plant food available in the deep, rich soils of the forest or grass lands that have been put under tea resulted in comparatively little attention being given to the question of manures, and plantations showing signs of exhaustion were abandoned for new land. During recent years, however, the value of manures has become more widely recognised, and in Ceylon their use is firmly established.

Compared with certain other crops, tea does not make great demands upon the soil, especially if the prunings, or the ashes obtained from them, are returned to the land. From what has been said above it will be seen that manuring will be carried out mainly in respect of nitrogen

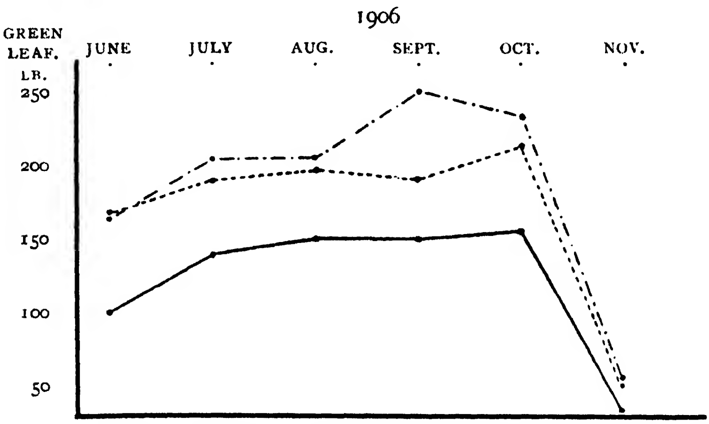


FIG. 1.—*Effect of Manures on Yield, Heeleaka Experiment Station,* 1906.

——— no manure.
· · · · · · · 20 tons cattle manure per acre (1905).
—·—·— 400 lb. oil-cake (mustard or rape) per acre.

and, to a less extent, phosphoric acid and potash. Valuable nitrogenous manures are often available locally: in India those chiefly used are peaty soil applied as a top-dressing, cattle-manures, and oil-cakes, and these materials are not only of value as manures, but their use also improves the physical texture of the soil and its power of retaining moisture. The top-dressings have been applied at the rate of about 300 to 400 tons per acre—most profitably in trenches between the bushes—but it will be evident that the value of the dressing depends upon its composition, and only those materials richest in organic matter and nitrogen will justify so great an expenditure in labour. Cattle-manure is now also used, especially mixed with wood-ashes and sweepings from the estate, the compound being trenched in between the rows. In the tropics animal

manure is often of relatively low quality, but experience has shown its value in tea cultivation, especially in the year succeeding the actual application (see Fig. 1).

In the absence of cattle-manure oil-cakes have been used with success. Those most commonly available in India are castor and mustard, but Bamber (Ceylon) has recommended coconut, poppy, cotton, and several other cakes. Experiments show that oil-cakes are best applied in small quantities annually, and that the results are quickly apparent (Fig. 1).

The use of chemical manures has also been successfully practised, more especially in Ceylon. Superphosphate, basic slag (with or without sulphate of potash), nitrates of potash, soda, and ammonia are those most commonly employed. It is impossible to prepare any fixed formula that will be equally efficacious in all soils, a fact illustrated by the results of an experiment carried out by Mann on different classes of Assam soils:

Manure, *per acre.*	Percentage increase of yield.	
	Heavy lands.	Light, sandy lands.
1. Superphosphate, 5 cwt.; Sulphate of potash, 2 cwt.; Nitrate of soda, 3 cwt.	32·3	20
2. Superphosphate, 3 cwt.; Nitrate of soda, 3 cwt.	24·7	17·2
3. Oil-cake, 6½ cwt.	8·3	17·7

In this experiment it will be noticed that the artificial manures gave higher percentage increases on heavy soils, while the oil-cake gave best results on the lighter soils. A comparison of the results of applications (2) and (3) to the light soils is of interest: the results are virtually equivalent, and a decision as to the use of either manure will depend upon relative prices.

Green-manuring.—A valuable source of nitrogen is secured by the practice of green-manuring, which is now widely known among tea-planters. It is common knowledge that plants belonging to the bean and clover family (Leguminosæ) accumulate nitrogen through the agency of bacteria which enter the youngest rootlets from the soil, causing the formation on the roots of clusters of "nodules" in which they live, multiply, and die. While living the bacteria possess the power of "fixing" the nitrogen of the air in the soil and elaborating it into a form available for the use of the host plant in which it is accumulated. Such plants, if dug into the soil in the green condition (hence "green manure"), afford a valuable supply of nitrogen, and, moreover, add to the organic matter in the soil. This latter advantage will accrue from the return

of any non-leguminous plant to the soil, but the addition of nitrogen will be small compared with that obtained when leguminous plants are used. The plants used on tea estates as green manures may be divided into two classes, viz. trees and shrubs grown more or less permanently, and herbaceous plants. In the former case the nitrogen becomes available by the decay of the large quantity of fallen leaves and debris, and also by that of the smaller roots, with their attached nodules. The "sau" tree (*Albizzia stipulata*), and *Dalbergia assamica* have been specially recommended for this purpose, and in Ceylon stout cuttings of the "dadap" (*Erythrina lithosperma*) have been planted between the tea bushes, and in due course the leafy branches lopped off and dug into the soil. A further beneficial result of the trees is the improved drainage of the soil following upon its abundant penetration by the roots.

In the case of the herbaceous annuals used for green-manuring the plants are raised from seed sown between the tea and dug into the soil when a few weeks old. The "mati-kalai" (*Phaseolus* sp.) has been widely used in northern India, and *Crotalaria striata* and *Sesbania cannabina* are recommended, the former being successfully used also in Ceylon. The ground-nut has been usefully employed, and the bush "boga medeola" (*Tephrosia candida*) is being grown in India for the same purpose.

PROPAGATION.—With the exception of the jats producing the Oolong teas of Formosa, tea plants are not raised from cuttings or layers, but from seed. Special plants are set apart for seed purposes, often in separate "seed-gardens," where the bushes are allowed to grow freely into small trees. The seed of certain districts of Assam is much sought after; it has been supplied to all tropical tea countries, and at the present time is being sent to Java and the new plantations in Sumatra. Tea seed does not retain its vitality for any great length of time, in this respect resembling that of the Para rubber tree. Reference has already been made to its possible use as a source of oil.

The young tea plants are raised in nursery beds, the seeds being sown 4 or 6 in. apart, in carefully prepared soil. When six or twelve months old (the former system is said to be gaining favour in India) the plants, with a ball of earth attached, are carefully removed from the nursery, the roots being trimmed if necessary, but never twisted or bent. The planting-distance is 4 to 5 ft. each way, in lines at right angles or at 60°, the latter system being known as "triangular planting." The necessity for careful removal from the nursery has resulted in the invention of special transplanting appliances which are coming into use among planters.

HOEING.—The cultivation of the soil is, in general, desirable from the early days of the plantation. Subse-

quently, in the greater part of the Indian tea area, cultivation is carried out as regular routine, but in Ceylon, Java, and the southern districts of India the conditions of climate or soil, or of both, render the practice less necessary, and in these countries hoeing is to a considerable extent replaced by hand-weeding. The chief advantages resulting from soil cultivation are well known: the water content of the soil is conserved by the destruction of weeds and the formation of a loose surface-layer which checks evaporation; the soil is aerated, and further supplies of plant-food rendered available; and the formation of a hard subsoil "pan" is prevented, especially if a deep hoeing is carried out to varying depths in successive seasons. Recently, a view has been put forward that the exposure of the soil to the hot sun ultimately results in an increase in the number of nitrate-forming bacteria in the soil, owing to the destruction of certain lowly organisms which normally prey upon them, the resistant resting-spores of the bacteria escaping a similar fate and subsequently flourishing.

In most Indian gardens there is usually an annual deep hoeing at the beginning of the dry season, when the soil is turned over to a depth of at least 8 in., the primary object being the protection of the soil (and therefore the bushes) from the oncoming dry weather. A light hoeing is carried out at intervals of about six weeks throughout the growing period, the soil being loosened to a depth of about 4 in.

PRUNING.—This operation has been described as the most important of the tea season. The main objects of pruning are (1) to produce a plant of size and shape convenient for economical plucking; (2) to increase the leaf-production of the plant; and (3) to remove all dead and unprofitable wood. Further, experience has shown that efficient pruning maintains or even improves the quality of the tea. It will be obvious that the gathering of the crop by the plucking of the shoot tips is virtually a "thumb-nail" pruning; the plant is stimulated to form more and more shoots, which are themselves removed in their terminal parts. In due course the readiness with which the laterals are formed begins to diminish with each successive plucking, and, if persisted in, such practice would finally lead to a condition in which the original shoots were hard and gnarled, with a dense terminal cluster of relatively useless, wiry twigs. Thus the light but repeated pruning involved in plucking results in a very undesirable state of affairs, the remedy for which is a more severe pruning. Much discussion has taken place as to the best method of pruning, but it is probable that no one system is equally well adapted for all tea-growing countries. The original Indian practice of encouraging the growth of the central

stem has long been abandoned, efforts now being directed to prevent its growth. In detail the means by which this is effected vary greatly, but the principles are essentially the same in all cases. Pruning in India is carried out during the non-growing period, and commences early in the life of the plant. The immediate object is to secure a bush of satisfactory shape—3 or 4 ft. high and more or less flat-topped, though many authorities favour a bush of rounded form. The young plant, when about twelve months old, is therefore cut down to within 6 or 8 in. of the ground, according to the jat. The main stem thereby removed is replaced by three or four laterals, which are allowed to grow for two years, when they are cut back to about 14 or 18 in. from the ground. The shortened branches in their turn give rise to laterals, and the plant commences to assume a definite shape. Subsequent prunings carried out annually, or at longer periods, are made back to a point a few inches above that of the previous pruning, guiding principles being the removal of all dead crowded branches and the retention of a small length only of new wood all over the bush. Such pruning is known as "light pruning" in India, and is carried out regularly every twelve months, but with less frequency in southern India and Ceylon, especially in the higher altitudes of the latter country. After ten or twelve years the bushes commonly show signs of decreased yield, for reasons already referred to, and in such cases "heavy pruning" may be resorted to, the whole bush being cut down to 12 or 15 in. from the ground. A good response is usually obtained, but after many years the yield may again become so low (especially in the absence of manuring and proper cultivation) that "collar pruning" is carried out, the plant being cut back almost level with the soil, just above the "collar." Heavy and collar prunings are drastic methods: a strong stimulus is provided, but the bushes become increasingly difficult to manage subsequently, and in hill districts or other areas growing delicate jats the practices are avoided as much as possible.

Plucking.—The harvest of the tea-planter is leaf, not fruit, and he may expect returns very early in the plant's life-history. A very small crop can be taken in the second year after planting out; in the third year 150 lb. of finished tea per acre per annum is obtained in the Indian plains; and by the sixth or eighth year the bushes should be in full bearing, yielding from 400 lb. to 1,000 lb. of finished tea per acre, according to local and cultural conditions. In India the average is about 500 lb. per acre, and yields above 800 lb. are exceptional. Remarkable yields have been recorded: a Ceylon estate has obtained 1,388 lb. per acre on a small area, and in Java a return of nearly 1,100 lb. per acre, over more than 2,000 acres, is mentioned.

From the horticultural point of view plucking is pruning. The planter's object is to obtain the maximum number of young shoots, and his harvesting operations themselves directly stimulate the plant to yield a further harvest. A brief reference may be made to the botanical principles upon which plucking is based. In the tea plant grown under natural conditions, as in other normal flowering plants, the new shoots do not arise indiscriminately upon the older branches, but only from the buds situated in the axils of the leaves of the older growths. The older branches continue their development by means of their terminal growing points, and, until growth ceases, add continuously to the leaf-surface of the plant. In due course, a certain proportion of the axillary buds begin to unfold into lateral (secondary) shoots, provided with leaves subtending buds

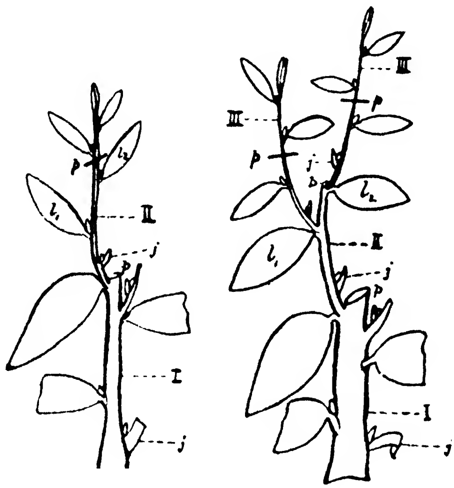


FIG. 2.—*Successive Flushes.*
I, II, III, successive shoots; *p*, point of plucking; *j*, janum leaf or bud-scale.
(Adapted from Watt and Mann, *Pests and Blights of the Tea Plant.*)

of the third order. If, however, the growth of the primary shoot is arrested by the nipping off ("plucking") of its terminal growing point, then the energy (food energy) intended for that growing point will be diverted to the lateral buds, and a larger number of secondary shoots will develop than under normal circumstances. Correlated with this phenomenon will be the effort on the part of the plant to restore the balance in its artificially restricted leaf-surface by the development of additional lateral shoots. The plucking of the secondary shoots results in the flushing of their axillary buds, and the process may be repeated several times. The tea plant growing naturally produces seven or eight successive series of shoots (natural flushes), but when plucked regularly the number

is increased (see Fig. 2). In India plucking is carried out every seven to ten days, there being twenty to thirty pluckings during the season; the pruning involved forces the production of a long series of shoots, and since the lateral buds on a shoot do not all develop simultaneously, a flush is ready for picking every seven to ten days. It frequently happens that the buds develop and later cease growth, without actually dying. Such shoots are known as "banghi" (barren) shoots, the treatment of which has caused much discussion among planters.

The actual procedure of plucking is well known. The first plucking or "tipping" is done when the new shoots are about 9 in. long and with not less than six leaves, excluding the apical bud and the bud-scale or "janum leaf" at the base of the shoot. The first pluck is carried out more for the purpose of supplying a stimulus for further flushes than for obtaining leaf. The flushes are taken every seven or nine days. In the best gardens only the youngest leaves are now plucked: the tip of the shoot, including two leaves and the terminal bud, is the standard pluck, and is removed by the thumb and finger; one leaf and the bud yields a finer tea, while three or four leaves, which will of course be older, constitutes a "coarse" pluck, giving a coarser tea. Occasionally, in order to secure a heavy crop late in the season, practically all leaf growth is removed ("close plucking")—an undesirable practice, for the bushes are left with very little leaf-surface to carry on their normal vital activities.

In general, the younger the leaf—the "finer" the plucking—the better will be the quality of the tea. It is commonly supposed that the finer grades of tea are composed exclusively of such young growths, but the use of modern equalising and sifting machinery has somewhat altered the circumstances of the case.

Manufacture

From the foregoing remarks it will be seen that the commercial success of tea-planting must in large measure depend ultimately upon cultural conditions that are to a greater or less extent under the control of the planter. Thus, differences of altitude, climate, and rainfall; differences of soil and jat; methods of pruning, manuring, and plucking, all have an influence, in one way or another, upon the yield of leaf in the final quality of the finished product. But, besides being grown, tea has to be manufactured, and it is difficult to judge the relative importance of the two phases of tea production. The case may be put thus: a correctly grown tea plant provides the possibilities of a good tea; it is the aim of good methods of manufacture to realise these possibilities to the fullest extent. No methods of manufacture will make a high-grade tea from

a low-grade leaf; but bad methods of manufacture will spoil a good leaf.

It is well known that in the manufacture of tea—black or green—the most important feature is the regulation of the fermentation (oxidation) process. With green tea this oxidation is not allowed to take place, but fermentation is the central fact of the manufacture of black tea. In making black tea all processes prior to fermentation are, in the main, designed to render a fermentation possible and to give it full scope; the processes subsequent to fermentation aim chiefly at "fixing" the results of the chemical changes brought about during the process. The significance of the various processes of the manufacture are best realised by bearing in mind the leading market points upon which the quality of a tea liquor are judged. These may be summarised as follows:

Flavour.—Flavour results from the presence of certain "volatile constituents," of which the most important is an essential oil. Full chemical knowledge of this oil is not yet available; it occurs in exceedingly minute quantities, and on exposure to the air quickly changes into a resinous substance, which has a marked tea flavour.

Pungency.—This property is caused in greatest measure by the unfermented (unoxidised) "tannin" present in the liquor. In these circumstances, therefore, it is to be expected that unfermented green teas should contain more "tannin," and therefore be more pungent, than black (fermented) teas made from similar fresh leaf.

Colour.—Colour is chiefly due to the presence of the fermentation (oxidation) products of "tannin"; it is therefore to be expected that black teas should possess more colour than corresponding green teas.

Body.—"Body" depends principally upon the total soluble matter which can be extracted from the leaf, and is made up in large part of "tannin," and its fermentation (oxidation) products.

Two points stand out strongly in the above remarks. The first is the importance of the much-abused "tannin." Whatever its physiological action, the commercial importance of the "tannin" is obvious: while the popular idea is that the harmful effect of the excessive tea-drinking is chiefly due to "tannin," the fact remains that, apart from special questions of flavour, the teas which the expert regards as the finest, and prices accordingly, are precisely those which contain the highest percentage of "tannin." A recent analysis of a "common Ceylon tea" liquor shows "tannin" present to the extent of 5·46 per cent., while in a "high-priced Ceylon tea" the figure was 7·56 per cent. It will be noticed from the tannin-relationships of pungency and colour that a vital point in tea manufacture will be how far the oxidation (fermentation) of the tannin is to be

allowed to go: if the oxidation is carried to completion the pungency will suffer; if not carried far enough, the colour will be unsatisfactory. It is always a question—and one to be settled by the experience of the planter—as to "how far pungency is to be sacrificed to colour." The second point is the absence of any reference to caffeine (theine) in the commercial estimation of tea. It is to this substance—an alkaloid present also in coffee, the cola nut, and, in small quantities, in the cocoa bean—that the stimulating effect of tea is due. It is obviously a most important constituent of tea, but the tea-taster takes no conscious account of the caffeine-content when judging the value of a tea. The prices of two samples of tea will have little or no relation to the caffeine present. It is true that the highest-priced teas are, in general, prepared from the youngest leaves of the plant, and that such leaves contain more caffeine than much older leaves, but these teas are valued on leaf and other characters, and not for caffeine. The case, however, is not so simple as would appear, for recent researches have shown the existence of a close relationship between the tannin and caffeine present in a tea liquor.

The highest development of tea manufacture is to be found in India, Ceylon, and Java. The history of the question reveals the familiar contest of hand methods versus machinery, with the usual triumph of the latter: the practice of tea manufacture has been revolutionised during the last forty or fifty years. Machinery is, of course, used exclusively on the European plantations of the three countries mentioned, but "hand" methods still play the chief part in the Chinese, Japanese, and Formosan industries, though the apparatus employed is by no means of the elemental primitiveness that is popularly supposed. It is worth recalling in this connection that in India itself, down to 1870, hand methods were almost exclusively used.

The leaf, as it is plucked from the bush, has several possibilities before it. It may be made into: (1) *Black tea:* forming the bulk of the Indian, Ceylon, and Java production, and the greater part of the Chinese export. (2) *Green tea:* produced chiefly in China, Japan, and Formosa; and, within recent years, to a small but increasing extent, in India and Ceylon. (3) *Oolong tea:* the characteristic tea of Formosa, which has been the subject of special enquiry on the part of Indian and Ceylon tea-growers. (4) *Brick tea:* of two kinds, made in China for the Russian and certain Asiatic (Tibetan) markets, and recently produced in small quantities in Darjeeling and Kumaon for export to Tibet and Bhutan. (5) *Letpet*, or *pickled tea:* produced in Burma and the Shan States for local use.

With the probable exception of the Oolongs, the different teas enumerated do not depend upon specific

differences in the tea plants concerned, but upon differences in manufacture. Black and green teas can be obtained from the same plant by respectively allowing, or preventing, fermentation. Brick and tablet teas are essentially nothing but green or black teas compressed into bricks or tablets, while letpet is tea leaf prepared in a unique fashion.

MANUFACTURE OF BLACK TEA.—A description of the methods introduced by the Chinese instructors into Assam in the earliest days of the industry is available in an old work by Bruce, the subject-matter of which has been rendered more accessible by Sir George Watt in his paper on the botany of the tea plant. The successive stages in the manufacture may be briefly noted as follows:

1. *Drying*.—The plucked leaf was exposed in large, flat baskets to the full glare of the sun, the baskets being arranged, several together, on a light bamboo framework.

2. *Withering*.—The baskets of dried leaf were then removed from the sun and placed upon a stand under cover in the shade until the leaves had "withered," *i.e.* become soft and flaccid.

3. *Panning*.—In the next process the withered leaf was thrown into a cast-iron pan heated almost to a dull red over a primitive fireplace, the leaf being vigorously stirred by hand to prevent any approach to scorching.

4. *Rolling*.—The heated leaf was then turned out upon a table and rolled by hand into a ball, the rolling being continued within the hands. It is probable that an imperfect "fermentation" (oxidation of the contents of the leaf-cells) took place during this process.

5. *Drying*.—The final process was a drying or firing of the manufactured leaf. The rolled leaf was dried in tall baskets, shaped like an hour-glass, the leaf being placed in the upper inverted cone (which was lined with paper), the lower cone fitting over a charcoal fire made in the ground.

It will be evident that, quite apart from the employment of machinery, modern methods of manufacture, as practised in India, Ceylon, and elsewhere, depart much from those just described. Sun-drying and panning previous to rolling are nowadays dispensed with, and the fermentation process, which played a relatively unimportant part in the earlier methods, is now the central fact of the manufacture of black tea. It may be said that the successful making of black tea depends ultimately upon the efficient control of enzyme (ferment) action, and the changes in methods of manufacture which have come about during the last half-century have been chiefly due to an increasing appreciation of this fact. The stages in the modern preparation of black tea are (1) *withering*, rendering the leaf sufficiently soft and pliable to be rolled without damage;

(2) *rolling*, which allows of the possibility of a free oxidation of the cell-contents of the leaf; (3) *fermentation* (oxidation) as a result of enzyme action; (4) *firing*, in which heat is employed primarily to arrest the action of the enzyme at a point known by experience to produce the best tea. It is interesting to compare the original and modern Indian methods of manufacture:

Assam, 1838. (Hand methods.)	Modern methods. (Machinery.)
1. Drying in sun.	(Absent).
2. Withering.	1. Withering.
3. Panning.	(Absent).
4. Rolling (probably involving imperfect "fermentation").	2. Rolling. 3. Fermentation.
5. Drying (firing).	4. Firing.

The various processes may now be considered in detail.

Withering.—This is the first stage. The plucked leaf, after being weighed, is brought at once into the shady withering-house and spread thinly on shallow trays ("tats") made of coarse hessian, bamboo, or wire netting, and arranged on racks; or the leaf is commonly spread on clean withering-floors. In the warmer tea districts of India, Ceylon, and elsewhere the withering-house is frequently a separate building, open to the air; but in the cooler hill-districts the upper story or loft of the factory itself is employed for this purpose, arrangements being made to warm the rooms with hot air.

The withering is complete when the leaf has become quite soft and flaccid, and at a temperature of 80° F. the process usually occupies from eighteen to twenty hours, though longer periods are commonly necessary. Special machines for withering the leaf are now used. A well-known type consists of two concentric cylinders of wire gauze rotating upon a horizontal shaft: the leaf is placed in the chamber between the cylinders, and through the inner cylinder hot air is passed, which percolates through the leaf and effects its withering.

The immediate object of withering is to obtain the leaf in a physical condition suitable for rolling, and it was formerly supposed that this was practically the only significance of the process. But it is now known that if withering is carried out under proper conditions of temperature and moisture (the leaf must never be allowed to become dry), the oxidising enzyme which brings about the all-important changes in the subsequent fermentation process greatly increases in quantity—"nearly doubles in amount." Further, there is an accompanying increase in "soluble matter" and soluble "tannin," each to the extent of approximately 4 per cent., so long as the leaf remains moist; and it has been found that the essential oil, to

which the flavour of the tea is in large measure due, increases during withering to the extent of about 15 per cent. It will be seen that the relationship between the time necessary for the reduction of the leaf to a suitable physical condition, and that required for the full "chemical" development of the cell-contents, is a matter of great practical importance. The loss of water, which results in flaccidity, and the production of the enzyme do not necessarily demand the same period of time; in very dry weather the leaf may be withered before it is fit to roll from the chemical point of view, and in wet weather the reverse may be the case. Between 76° F. and 86° F. the enzyme increases in amount for eighteen hours and then diminishes, and hence it is very desirable that the leaf should be sufficiently flaccid for rolling at the end of that period. The employment of artificial means of controlling withering, by the use of currents of warm air, would thus appear to afford an opportunity of securing the theoretically perfect withering, and reference has already been made to the machines designed with this object in view.

It is important that the withering trays, together with all apparatus and appliances used throughout the processes of manufacture, should be kept scrupulously clean and completely sterilised (preferably by scalding or steaming), since the presence of bacteria sets up fermentation changes which sour the leaf.

Rolling.—This is the next step. The most obvious result of the rolling is to give the tea its characteristic "twist"; but rolling, no less than withering, is in large measure subservient to the fermentation. This latter process is essentially an oxidation of the cell-contents of the leaf: the materials to be oxidised are in the leaf tissue, as is also the enzyme; the oxygen is outside the leaf, in the atmosphere. Oxidation will therefore not be complete until the three are brought into contact, and this is effected by rolling. In this process, the leaf-cells are ruptured and the juice (sap) pressed out on to the surface of the leaf, with the result that, under the influence of the enzyme, its constituents combine with the atmospheric oxygen. It will be obvious that with *light* rolling, less juice will be expressed and, in consequence, less fermentation (oxidation) will be possible, and the resultant tea liquor will be pungent owing to the relatively large proportion of "tannin"; but the colour (due to fermentation products of "tannin") will be pale. If the rolling be *hard*, then more juice will be expressed and oxidised, and the liquor will be less pungent, but will possess more colour and body.

The quantity of essential oil in the leaf, which advances during withering, increases at a still greater rate during the rolling, experiments by Mann showing that the increase is

from 13·8 to 25 per cent. on the amount in the fully withered leaf just previous to rolling.

The rolling process was formerly carried out by hand methods (as it is in China, Japan, and Formosa at the present day), the leaf being spread out upon a table and worked or kneaded by the hands, or placed in baskets upon the floor and worked with the feet. It is a process that lends itself readily to mechanical treatment, and there are now several types of rolling-machines, all of which operate by rubbing the leaf, under adjustable pressure, between two surfaces, one of which may be fixed with the other moving over it, or a motion may be imparted to both surfaces by an ingenious system of double cranks with unequal arms (see Fig. 3). The withered leaf is fed into the "jacket," which is provided with adjustable screw pressure to hold the leaf against the "rolling-plate." The time occupied in the rolling varies with the character of the leaf, the type of machine, and the size of the charge. At the end of from 15 to 60 minutes the rolling may be complete and the whole charge of twisted and ruptured leaf is removed from the machine through a trap-door.

It will be obvious that the delicate, younger leaves will be rolled before the harder, older leaves, and the "roll" is therefore sifted through rotating cylindrical sieves, the older leaves being submitted to a further rolling under increased pressure. The sieves are often provided with rapidly revolving beaters which break up the irregular balls of leaf which form during the rolling: such machines are known as "ball-breakers."

Fermentation.—During the rolling, the cell-sap, which also contains the enzyme, is brought into contact with atmospheric oxygen and oxidation commences. The subsequent fermentation process is arranged to encourage this chemical action, and the rolled leaf is therefore transferred to the relatively cool, darkened fermenting-room, and spread out in layers 1 or 2 in. thick to give full access to the air, which should be freely admitted.

The optimum temperature would appear to be from 80° F. to 82° F., and the atmosphere of the room is kept moist by suspended wet cloths. In small factories the leaf is placed on shelves or in trays arranged in tiers to economise space, but where larger quantities of leaf are dealt with, special fermenting floors, made of cement, tiles, or squares of plate-glass, are employed. The leaf, when placed upon these floors, is covered with damp cloths, which should be so arranged that they do not actually touch the fermenting leaf. The sterilisation of the floors and cloths is ensured by frequent scouring and steaming.

Knowledge of the changes taking place during fermentation is largely due to Bamber and Mann, whose results have been confirmed by Japanese and Dutch observers.

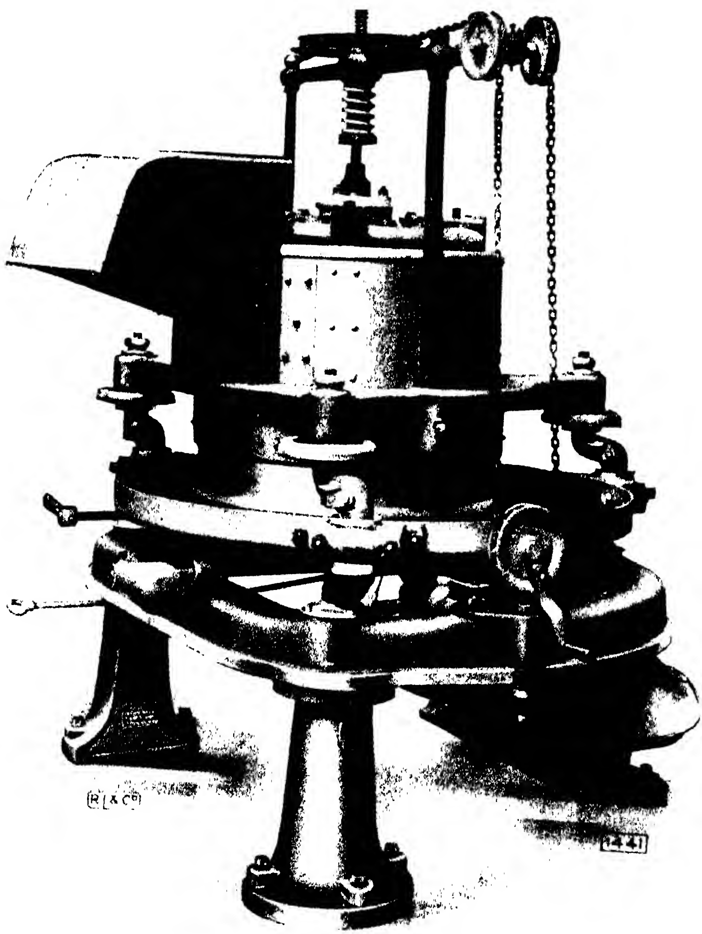


FIG. 3.—Jackson's Patent "Metallic Double-action Rapid" Tea Leaf Rolling Machine.

Early ideas as to "putrefaction" and putrefactive bacteria playing the essential part in the fermentation gave way to Bamber's first view (1893) that the process was one of chemical oxidation; but in 1900 Bamber definitely showed that an oxidising enzyme (oxidase) was the active agent in bringing about the changes so familiar to the tea-man, and this view has received abundant confirmation.

While the processes are by no means fully understood, it would appear that the first chemical change is that the "tannin" becomes slightly oxidised and forms brown products which unite with the caffeine present. This is quite in accord with practical experience, for, by the end of the rolling, the leaves have already begun to change from green to brown, and to possess a distinct "tea" as opposed to a "leaf" odour. All the "tannin" pressed out of the cells during rolling and brought into contact with the air can be oxidised through the action of the enzyme in from 4 to 6 hours, according to the temperature, and fermentation is thus an operation that becomes complete after a definite time. If such complete fermentation is allowed to obtain, the relative pungency and colour of the tea liquor must depend upon the amount of juice expressed. But, in practice, it is a matter for decision as to how far the fermentation is to be allowed to proceed—how much "tannin" is to be oxidised (to give colour and body) and how much left unoxidised (affording pungency). As the fermentation proceeds, the leaf rapidly changes in colour and finally attains a bright copper shade, by which time the true odour of finished tea is assumed. The temperature should, if possible, not be allowed to rise above 80° to 82° F., or further oxidation of the "tannin" takes place, independently of fermentation, resulting in the production of more or less insoluble, dark brown products which greatly depreciate the tea and impart to it a "stewed" taste.

The flavour of the tea is also developed during the fermentation. The rise in the percentage of essential oil during rolling is continued, but with gradually decreasing speed, and usually the maximum quantity of the oil is reached during the first half of the fermentation, after which it shows a tendency to decrease. Thus, so far as chemical changes are concerned, there is a clashing of interests in regard to the development of flavour on the one hand and the production of a good liquor on the other, since a good liquor demands a full oxidation. A compromise must be effected, and therein lies the scope for the tea-maker's experience.

Firing or Drying.—It will be obvious that some ready means of arresting the action of the enzyme at any desired moment is necessary in order to control the quality of the resultant tea. Heat is the agent employed, but while formerly the tea was "fired" or dried over charcoal fires

(as it still is in the Far East), in modern factories the work is done in large, automatic machines or "tea driers," in which hot air is drawn through the tea by suction or forced through it under pressure, in both cases by means of fans (see Figs. 4 and 5). In a well-known drier three parts may be distinguished: (1) the large air-heater, with its numerous intake pipes, from which the hot air passes into the main section of the apparatus, (2) the drying-chamber: the air enters the lower part of this chamber and is withdrawn from the top by means of (3) a circular fan driven at a high speed. The drying of the tea is effected in the drying-chamber, in which is arranged horizontally, and one above another, a series of endless bands serving as tables, each running on a roller at either end. The tables are flexible and built up of

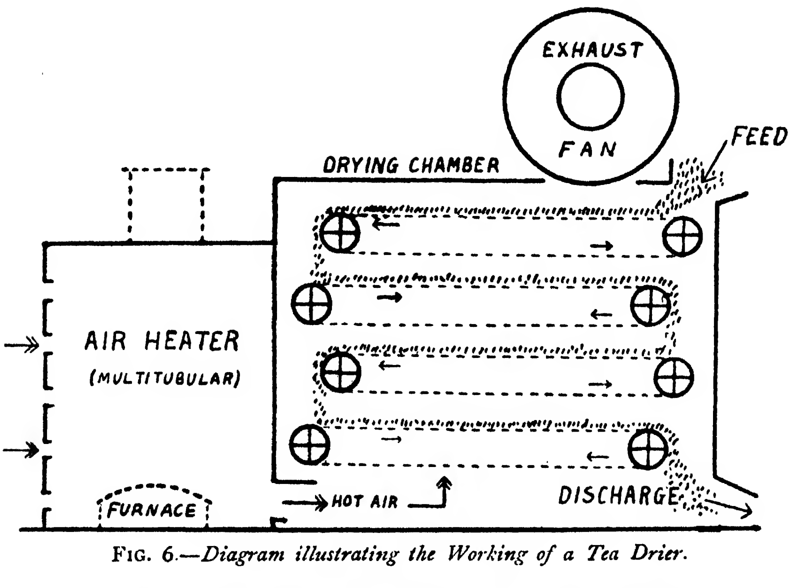


FIG. 6.—*Diagram illustrating the Working of a Tea Drier.*

a series of narrow slats of perforated metal, hinged along one edge, the other being free. The tea is fed on to the uppermost table, which, travelling slowly forward, carries the tea with it until the slats reach the further roller, where they turn down to make the return motion. The tea thus falls on to the table below, which is travelling in the reverse direction; but the slats, being hinged, not only turn down but also turn over, and in doing so, more or less completely invert the tea as it falls on to the lower table, thus allowing of a more satisfactory drying. The procedure is repeated at the end of the second table, the tea falling to the third table (which has the same motion as the first), and so on through the machine, common types of which possess seven such tables. The discharge is effected at the bottom of the drying-chamber. A sketch illustrating the essential working of such a machine is given in Fig. 6.

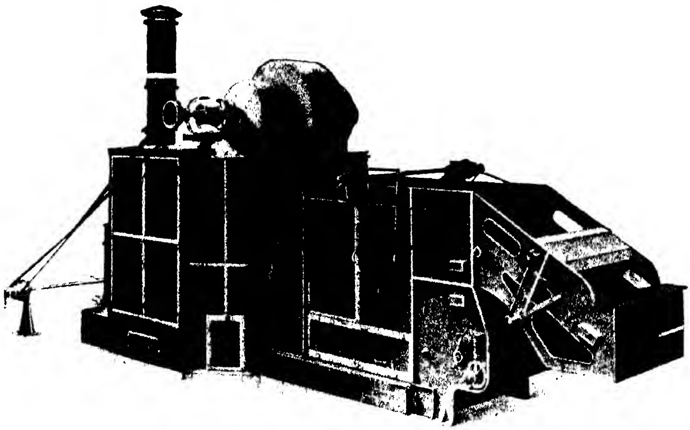


FIG. 4.—Jackson's Patent "Empire" Tea Drying Machine, showing new Patent Extended Feeder.

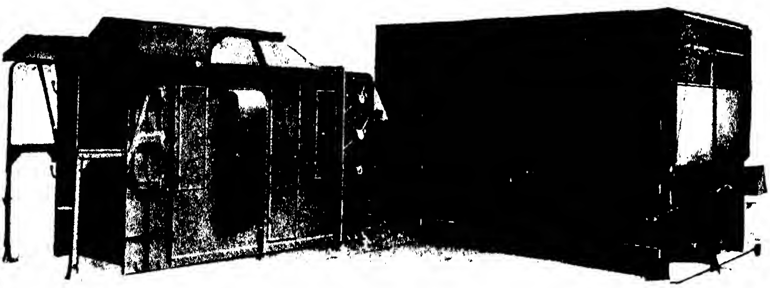


FIG. 5.—Davidson's "Sirocco" Endless Chain Pressure Drier, Small Size. Right-hand Machine, Front View.

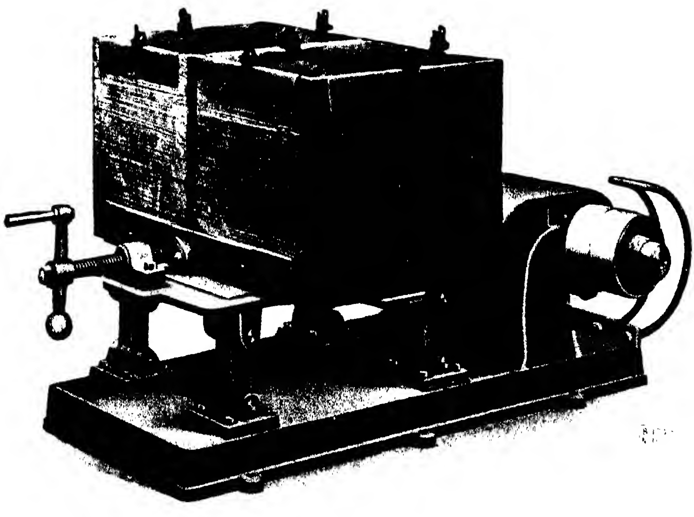


FIG. 7.—Jackson's "Compound" Tea Packing Machine.

The temperature of the air entering the machine is usually maintained at 220° F. to 240° F., but that of the leaf itself will necessarily be lower. The time required for drying varies under different circumstances: it is commonly about 25 minutes, and when the process is about three-quarters completed the temperature is lowered to 180° F. to 200° F. A second firing, at a temperature of about 200° F., is frequently carried out.

The two main objects of the firing are to arrest fermentation by the destruction of the enzyme, and to dry the tea. The enzyme must be destroyed as quickly as possible, so that no further oxidation of tannin and other substances shall take place, with a corresponding reduction in the pungency of the finished tea. Further, it would appear that certain chemical changes take place during the firing which improve the flavour of the tea. The process must be carried out rapidly (but without scorching), and all "stewing" of the leaf at a relatively low temperature is to be carefully avoided, for under such conditions the wet leaf loses still further quantities of "soluble matter" by the decomposition of the tannin, and the pungency suffers for the same reason; while the flavour is reduced owing to the volatilisation of the essential oil.

Grading.—After firing, the tea (black or green) is ready for assortment into different grades. Apart from the grades of "Fannings" and "Dust," which represent the smallest possible fragments of leaf, it is commonly supposed that the grades depend entirely upon the age (and therefore size) of the leaf plucked: thus, Orange Pekoe would consist of the youngest leaf and the terminal bud; Souchong, the oldest leaves taken from the shoot; while Pekoes would be the intermediate leaves. Broadly speaking, this view is correct, but the relationship now holds less rigidly than formerly, since the mechanical sifting of the fired tea may allow of fragments of older leaves passing through with the smaller, younger leaves. Two types of sifting machines are employed—cylindrical sieves (with varying meshes), rotating with the long axis slightly inclined to the horizontal; and oscillating tables fitted with wire sieves. Both types are worked by power.

The scale of grades is somewhat variable, but in black tea four main grades are commonly recognised, viz. Orange Pekoe, Pekoe, Pekoe Souchong, and Souchong, in descending order of value; while the finer fragments that become separated from a main grade constitute the "Broken" quality of that grade, and command a higher price. In the case of green tea, such broken grades are of small value, and the grades would appear to have a closer relation to the age of the leaf. The principal market grades of black and green teas may be stated as follows:

Black tea.	Green tea.
Leaf grades :	*Leaf grades :*
1. Broken Orange Pekoe.	1. Young Hyson (= Orange Pekoe, approx.).
2. Orange Pekoe.	2. Hyson, No. 1 (= Pekoe „).
3. Broken Pekoe.	3. Hyson, No. 2 (= Pekoe Souchong „).
4. Pekoe.	4. Gunpowder.
5. Broken Pekoe Souchong.	
6. Pekoe Souchong.	*Siftings :*
7. Broken tea.	1. Twankay.
8. Souchong.	2. Fannings.
	3. Dust.
Siftings :	
1. Fannings.	
2. Dust.	

The coarser leaf of black tea, e.g. Souchong, is commonly reduced, or "equalised," by being passed through a cutting machine or "equaliser," where it is chopped to a smaller size.

Final Firing.—After grading, the tea is stored in air-tight receptacles until it is ready for packing. Previous to the latter, the tea is subjected to a "final firing" to dry it thoroughly. Machines of essentially the same type as the ordinary firing machines are used for this purpose.

Packing.—The tea is then ready for packing in the well-known lead-lined chests. Formerly all the packing was done by hand, and this method is still commonly used for packing the coarser leaf, but special machines are now largely employed. The chests are clamped to the machine, singly or in pairs, and subjected to a rapid oscillatory movement, during which the tea, just warm from the final firing, is poured in by a coolie (Fig. 7). Great care is necessary in soldering down the chests, since, as is well known, tea is exceedingly liable to absorb moisture and odours, with detriment to its commercial value; it is of supreme importance that the tea-chest should be hermetically sealed. Many woods are unsuitable for making the chests, since they impart undesirable flavours or odours to the tea. In India the chests were formerly largely made of "toon" wood (*Cedrela Toona*), but many timbers have been and are employed for the purpose, and at the present time patent boxes, made of three-ply wood (chiefly pine), are coming into use.

Post-fermentation changes.—It has long been known in the trade that differences in flavour exist between tea freshly manufactured and tea that has been stored some time, even under completely satisfactory conditions. Recent work in Java, by Welter, seems to afford some explanation of this fact, though full knowledge is not yet available. Welter has shown that definite chemical changes take place in tea after it has been fully manufactured, the chief being the liberation of small quantities of carbon dioxide

(carbonic acid gas), quite independently of any oxidation of the leaf-tissue by atmospheric oxygen. The formation of this gas would not appear to be due to bacterial action or yeast fermentation processes, and it has been suggested that once more we have the result of enzyme action, though it would appear difficult to concede this in the face of the severe conditions obtaining in the firing and final firing processes.

MANUFACTURE OF GREEN TEA.—The firing process, which is virtually the last stage in the manufacture of black tea, becomes the first process when green tea is to be made, the object being to prevent the possibility of fermentation. In the first process, therefore, the enzyme in the leaf is destroyed by heat as soon as the pluck is taken to the factory, and fermentation is thereby prevented. The Chinese method is by "panning," *i.e.* the heating of the leaf in cast-iron pans set in a simple brickwork furnace, the leaf being agitated by hand to avoid scorching. When small quantities only are required this method is fairly convenient, and by no means inefficient; but where large quantities are dealt with the employment of machinery is more satisfactory. Green tea is now being made in India (especially Southern India) and Ceylon for the North American and Russian markets, and in these countries machinery is generally used. The plucked leaf is placed in a steam-heater and subjected for 1½ to 2 minutes to a steam pressure of about 20 lb. per square inch. The steaming must be sufficiently prolonged to destroy the enzyme completely, but anything approaching a "boiling" of the leaf will render the latter useless. When steamed, the leaf is removed from the heater and placed on one side to cool, after which it is transferred to a centrifugal machine to expel the excess of water. The tea is then slightly rolled in an ordinary rolling-machine, but since fermentation is not to be carried out, no preparation for such a process is necessary, and the rolling is therefore very light and short. Moreover, broken grades of green tea are of little commercial value, and on this account also light rolling only must be allowed. The subsequent processes of firing, grading, etc., are then carried out as in the case of black tea.

Green tea possesses a "feel" quite different from that of black tea, being far more soft and silky; it becomes somewhat sticky during the manufacture, this being especially the case with the smallest (youngest) leaves, which cause the tea to adhere in small balls, as in the grade of green tea known as "Gunpowder."

The artificial colouring of green tea in China will be referred to in dealing with the tea industry of that country.

BRICK TEAS.—These famous teas form an important item in the Chinese tea trade, nearly 34,000,000 lb. being

exported in 1911. Two distinct kinds of brick tea are made—viz. the brick (and tablet) teas intended for the Asiatic and certain European provinces of Russia; and the brick teas for Tibet. The two kinds differ in methods of manufacture, physical qualities, and manner of domestic use. The brick and tablet teas for Russia are essentially nothing but the finer siftings and dust of ordinary tea compressed into slabs, and it is probable that this form was adopted to economise bulk in the lengthy overland transport from China to Russia. The industry was originally in the hands of the Chinese, but it has now passed under Russian control, the bricks being made in modern factories, equipped with hydraulic machinery, at Hankow. Factories formerly existed also at Kiukiang and Foochow, which as recently as 1911 exported small quantities of brick tea. The relative importance of the three centres will be seen from the exports (1911): Hankow, 206,000 pikuls; Kiukiang, 40,000 pikuls; Foochow, 8,000 pikuls (1 pikul = $133\frac{1}{3}$ lb.).

In the manufacture of the bricks both green and black tea-dusts are used. The bulk of the material is still of Chinese origin, but within recent years large quantities of siftings and dust (10,000,000 to 15,000,000 lb. annually) have been imported into Hankow from India, Ceylon, and Java. This imported material is used alone to make the bricks, or it may be mixed with China dust, to the extent of 40 to 50 per cent., to form the "blended" bricks, which give a stronger liquor than those made from China teas only. The process of manufacture is essentially as follows: the dust is sifted into grades, steamed in cotton bags, and then poured into wooden moulds measuring about $9\frac{1}{4}$ by $6\frac{3}{4}$ by $\frac{3}{4}$ in. Formerly the moulds were transferred to lever presses, but powerful hydraulic appliances are now used, the moulds being kept in the machines until the bricks harden. The bricks, when cooled, weigh from $1\frac{1}{2}$ to 2 lb. each, and are hard, smooth, and of surprising toughness; the trade-mark of the firm is impressed on each brick while in the mould. For export, the bricks are wrapped in white paper and packed in bamboo baskets for export. *Tablet* tea consists essentially of small bricks, weighing a few ounces each, and is made from very fine tea-dust of special quality. Accounts of the details of manufacture vary. The dust is said to be placed in the moulds direct, and steamed while in the moulds, after which it is submitted to great pressure. The tablets are wrapped in tin-foil and paper, and packed in tin-lined boxes.

The brick tea for the Tibetan market is of a different character, and is made entirely by Chinese at Ya-Chou and Ta Chien-lu, in the Szechwan province. The industry was investigated by Hutchison in 1905 on behalf of the Indian Tea Association. Leaf, not dust, is used. The best-quality

brick is made from the young shoots, but for the average brick very coarse material is used, stalks, twigs, and even clippings being freely employed, and often forming the bulk of the pluck. This coarse pluck is panned for six to ten minutes, rolled lightly by hand, and then submitted to a special fermentation process, in which the leaf is spread in layers 3 or 4 in. thick and allowed to ferment for three or four days, the temperature meanwhile rising from 105° F. to 112° F. The material is then dried in the sun. In making the bricks, the fermented leaf is steamed until moist, and then rammed lightly into a wooden mould of varying size, common dimensions being 10½ by 4 by 4 in. When young leaf, comparatively free from stalk, has been employed the material adheres readily under pressure, but for the coarse, stalky material a dressing of glutinous rice-paste is used to effect adhesion. The pressed bricks are then placed, several together, in a wooden frame and stood on one side to dry and harden. When ready, they are wrapped in paper and packed in bales made of wet hides, the contraction of which ensures a strong, safe package. The finished brick is quite different from the smooth, hard brick of compressed dust, being easily broken up into a loose mass of leaves and twigs. The two kinds of brick also differ in methods of use. The compressed brick is used for ordinary infusions, but the Tibetan brick tea is boiled with salt, butter, and other ingredients to form a kind of soup.

Small quantities of brick tea have been made in Darjeeling and Kumaon for the Tibetan and Bhutan markets.

Letpet (Leppet) Tea.—This form of tea is prepared only in Burma and the Shan States, and in certain neighbouring districts; it does not enter into external commerce. Possibly the main interest attaching to letpet is that its use is identical with that to which tea was put in very early times, viz. as a vegetable rather than as a material for infusions. It consists of tea-leaves preserved on the principle of the fodder silo, viz. by consolidation under pressure without access of air. There would appear to be two methods of preparation. East of the Irrawaddy the young leaves are plucked and then softened by steaming, after which they are rolled by hand. When cool, the leaves are packed into a pit in the ground lined with boards or bamboo mats. Pressure is then applied by piling heavy weights on a cover placed over the leaf. In due course the latter matures to a yellowish colour, when the pit is opened and its contents sold. West of the river a different process is employed, though the principle remains the same. The leaf is placed in boiling water (not steamed) until soft, and then rolled and allowed to cool. It is then rammed tightly in a length of bamboo retaining one of the natural diaphragms, and the top closed with a stopper of leaves.

The bamboo is then stood upside down to drain the leaf, and later a plug of moist ashes is inserted to keep out insects. The charged bamboos are then buried in the ground for the letpet to mature.

Letpet is seldom used as a beverage. It is eaten alone, or, more commonly, mixed with salt, oil, garlic, and other ingredients, to form a kind of salad. From the earliest times the material has entered largely into Burmese life and customs, being used at birth, marriage, and funeral ceremonies. Specimens of letpet and of the bamboos used in its preparation are exhibited in the Indian Court at the Imperial Institute.

The Cultivation of Tea in Different Countries

India

It seems probable that the advantages resulting to the East India Company from their monopoly of the China tea trade largely contributed to the delay in establishing a tea industry in India. Difficulties with China, however, induced the government to urge strongly upon the company the desirability of establishing a further source of supply in India, and the first tea planted in India was raised from seed obtained from China in 1780. This tea was planted in Calcutta by Captain Kyd, but no progress appears to have been made at this time. Eight years later the importance of the question was brought to the notice of Warren Hastings by Sir Joseph Banks, who recommended experimental planting in Bihar, Rangpur, and Kuch Bihar. Nothing definite was accomplished, however, until 1834, when the Tea Committee, established in that year by the Governor-General, Lord Bentinck, sent a commissioner to China to obtain seeds and Chinese instructors. The Committee, however, were not aware that between 1819 and 1824 a fine variety of tea plant had been found growing wild in India itself—in Assam and Manipur; and at the time the commissioner, Gordon, was actually away in China, the plant was again discovered in Assam. Gordon was recalled, and much discussion ensued as to the relative merits of the Indian and Chinese plants and the most favourable localities for establishing plantations. It was decided that the most promising areas were Assam, certain districts in the Himalayas, and the hills of Southern India; the Chinese plant was to be grown, though the merits of the Indian variety were strongly upheld by individuals. Further supplies of seed and additional instructors were therefore obtained from China by Gordon, and in 1844 the botanical collector, Fortune, was despatched to China for similar purposes. Experience has shown that of the three principal localities chosen, Assam has proved to be by far the most suited to tea, and that in selecting the Chinese plant as the basis for

the Indian tea industry a mistake was made which has taken many years to repair. The superiority of the Indian plant for Indian conditions is now established beyond question.

The industry was at first entirely in the hands of the government, but its success was so quickly assured that by 1865 all the plantations had been handed over to private enterprise. A sample of Indian tea was sent to England in 1838, but the first public sales took place two years later in Calcutta. Tea cultivation rapidly extended in all districts where the climatic conditions offered chances of success, and before long planting was being carried out on the most reckless scale, and under the wildest conditions of finance and management. The inevitable disaster came in 1865–7, and threatened to ruin the young industry; it was not until 1869, when stability had been restored, that the industry once more went forward, and it may be said that since that date—during a period that has witnessed profound changes in methods of management, cultivation, and manufacture, and "the elimination of everything Chinese"—the industry has never looked back. The remarkable advance will be seen from the following figures

	Acres.	Export (approx.). lb.
1838 . . .	—	488
1841 . . .	—	4,613
1877–8 . . .	188,000	36,000,000
1887–8 . . .	324,000	100,000,000
1897–8 . . .	502,000	157,000,000
1907–8 . . .	548,000	228,000,000
1911–12 . . .	575,000	264,000,000

The principal producing areas will be seen from an analysis of the acreage for 1911. The official returns are as follows:

	Acres (1911).
ASSAM: Brahmaputra Valley, Surma Valley (Cachar and Sylhet)	354,276
EASTERN BENGAL: Jalpaiguri, Chittagong	95,268
BENGAL. Darjeeling, Chota Nagpur	53,737
NORTHERN INDIA:	
(*a*) United Provinces: Dehra Dun, Almora, Garwhal . .	7,612
(*b*) Punjab: Kangra	9,381
SOUTHERN INDIA:	
(*a*) Madras: Nilghiri Hills, Malabar, etc.	20,593
(*b*) Travancore	32,000
BURMA (Letpet tea)	1,700
Total number of persons employed (1911) . 613,962	

It will be seen that Assam and the Bengal areas together comprise nearly nine-tenths of the total acreage under tea in India. The areas of northern India, although selected for experiment in the earliest days of the industry, and still existing as well-known tea districts, remain very small; they are remarkable for their highly flavoured teas, which, however,

are yielded in comparatively small quantities. Southern India, and especially Travancore, is the youngest district from the commercial point of view, though experimental areas were laid at the commencement of the industry. The Nilghiri Hills first came into prominence as a tea country after the crisis in 1867, and Travancore still later. The Burma industry is concerned almost exclusively with the production of letpet tea, which is consumed locally.

The number of plantations comprising the total acreage is returned as 4,414. Their individual areas vary greatly in different parts of India: in Assam the gardens average from 300 to 400 acres; in Madras 142 acres; United Provinces 129 acres; while in the Punjab, where the industry is on a very small scale, the average is no more than 3 acres. The lowest limit is reached in Burma, where the tea is grown in scattered patches cleared in the jungle.

The yield of finished tea per acre also varies greatly in the different tea districts. As mentioned previously, improved methods of cultivation have resulted in a remarkable increase during thirty or forty years, an improvement of nearly 100 per cent. being recorded since 1875. In 1911 the average yield for all India was 504 lb., the returns (lb. per acre) for the different districts being as follows:

Jalpaiguri (E. Bengal)	585	Sylhet	561	Darjeeling	284
Travancore	567	Dehra Dun	438	Kangra	160
Cachar	564	Nilghiris	369	Hazaribagh (W. Bengal)	23

Green Teas in India.—Within recent years, considerable attention has been paid, in both India and Ceylon, to the manufacture of green teas, with a view to competing in the markets served with these teas by China and Japan. The chief buyers of green teas are Russia (both European and Asiatic) and North America, especially the United States, while smaller quantities are taken by the continent and north Africa. In India, green tea was made in considerable quantities in the early years of the industry, but the change in public taste caused the manufacture to disappear, except in Kumaon and the Kangra Valley, the latter district still sending small quantities of lightly-faced green teas to Persia. Modern developments are chiefly in the Surma Valley and northern India, and a remarkable advance has recently been made by southern India. The figures of reported production are as follows:

	1909. *lb.*	1910. *lb.*	1911. *lb.*
Surma Valley	895,000	1,375,000	1,756,000
Other parts of Assam, Eastern Bengal, and Bengal	272,000	246,000	443,000
Northern India	1,251,000	1,310,000	1,409,000
Southern India	260,000	164,000	1,602,000
Total	2,678,000	3,095,000	5,210,000

With the exception of the Kangra Valley tea, Indian (and Ceylon) green teas are not faced, and the consequent purity of the article should constitute a valuable asset in meeting the new requirements of the government of the United States in respect of imported green teas.

The Tea Cess.—An interesting feature of the Indian industry has been the organised effort on the part of the planters to increase the sale of their product in existing markets, and to find new outlets, not only in continental Europe, but also in the United States, Canada, Australia, and even Asia; moreover, the possibilities of the Indian peoples themselves as tea-drinkers have not been overlooked. This advertising activity has been made possible by the establishment of a Cess Fund—a fund based upon taxation voluntarily assumed by a community for the advancement of its common interests. The following particulars of the Indian Cess Fund have been kindly supplied by Mr. W. Skinner, of the Indian Tea Association. The first movement was a voluntary levy on the planters, coupled with a government contribution, for the purpose of advertising Indian teas at the Chicago Exhibition of 1893. The levy was continued on the same lines until 1903, when a Tea Cess Act was passed making compulsory a small tax on all exported tea. The tax, which was to be in force for periods of five years, was to be collected by the government and the fund administered by a representative committee. The amount collected in 1911 was £22,494.

During the early part of the present year (1913) the Cess was renewed for a further period. The continuance of the tax is sufficient evidence of its commercial value. The money has been expended on many forms of advertisement calculated to enhance the sale of the product, and much success has attended these efforts, notably in the United States and Russian markets, which have greatly increased their imports of Indian (and incidentally Ceylon) black and green teas. It will be convenient to mention here that a similar Tea Cess Fund was established in Ceylon in 1892, but discontinued in 1908.

It seems probable that the local Indian demand for teas may well result in the establishment of a market of considerable value in the not very distant future. Small quantities of foreign teas (largely Chinese greens) have long been imported into India for local consumption, and the amount is increasing, while home-grown teas are now rapidly rising in favour. In 1910-11 the total consumption of tea in India amounted to 15,810,000 lb., but in the following year the amount had risen to 22,150,000 lb. An analysis of these figures is of interest:

	1910–11. lb.	1911–12. lb.
Imports of foreign tea	8,250,000	10,970,000
Less re-exports of foreign tea	845,000	760,000
Foreign tea left in India	7,405,000	10,210,000
Calcutta auction teas for local consumption	6,865,000	9,518,000
Sent from Calcutta to Bombay	2,900,000	3,922,000
	17,260,000	23,650,000
Less Indian tea exported from Bombay	1,450,000	1,500,000
Total tea for consumption in India	15,810,000	22,150,000

Ceylon

Tea-planting in Ceylon may be fairly regarded as an offshoot of the Indian industry, but the offshoot has become a serious competitor of the parent stock, Ceylon at the present time being by far the most important rival of India. The statement that an attempt at tea-cultivation was made by the Dutch is now discredited, but it is definitely known that Assam tea was planted at Nuwara Eliya in 1836, and that China tea was grown on the Worms estate at Pusilawa in 1841, though no manufacture was possible on account of lack of skilled labour. As is well known, the modern industry rose upon the ruins of coffee-planting, brought about by the coffee-leaf disease. In the years that followed that calamity strong efforts were made to retrieve the situation by planting cocoa, cardamoms, and cinchona, but no permanent relief was obtained until tea-planting was definitely undertaken. The climate of the island was found to be pre-eminently suited to the plant, and the 250 acres put under tea in 1873 were increased to 35,000 acres in ten years. The development of the industry is illustrated in Fig. 8.

In the tea "curve" of the diagram (p. 289), the most noticeable features are the rapid rise during the earlier years of the industry and the comparatively stationary condition at the present time. A fall in prices brought about a check to expansion in 1896 to 1900, and in recent years an additional factor has been the remarkable interest in rubber-planting in Ceylon, with the result that about 77,000 acres of tea gardens in the low country have been interplanted with the new crop. Recently, however, several clearings for tea have been made in both low country and hill districts, and new estates are coming into bearing, and in point of fact the export in 1912 was estimated at over 5,000,000 lb. in excess of that in 1911. Tea still remains the chief crop of Ceylon, with an area of 395,000 acres as against rubber with 265,000 acres (Ferguson, 1912). The labour is recruited from the Tamils of the Madura and other districts of southern India, and at the present time about 520,000 coolies are employed.

The growth in the exports is shown in the following figures:

Year.	Export. lb.	Year.	Export. lb.	Year.	Export. lb.
1873 .	23	1903 .	149,227,000	1911 .	186,594,000
1883 .	1,666,000	1909 .	192,886,000	1912 .	192,000,000 (est.)
1893 .	82,269,000	1910 .	182,070,000		

The tea districts of Ceylon are mainly situated in the mountainous central region of the island, up to nearly 7,000 ft., but there is a large area in the south-western plains. Above

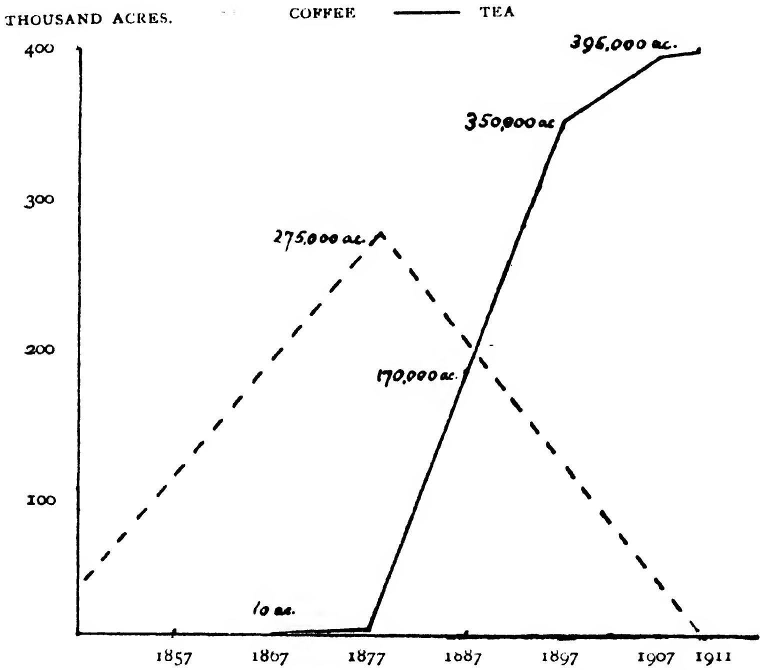


FIG. 8.—*Acreage under Tea* 1867-1911 *compared with the maximum under Coffee.*

2,500 ft. tea forms practically the only cultivation, and the district between Kandy and Nuwara Eliya is said to afford one of the most striking examples in the world of a large stretch of country covered with a single crop. The three most important tea districts are Dimbula (47,000 acres), Dikoya (30,000 acres), and Badulla (22,000 acres). The tea area coincides with the region of maximum rainfall, practically all the tea being grown with not less than 70 in. per annum, and the majority with much more. This fact, combined with proximity to the equator, results in an almost continuous flushing in contrast with conditions accompanying the resting season in many parts of India and throughout the Chinese, Japanese, and Formosan tea districts. In general

the low-country teas of Ceylon are inferior in quality to the hill teas, but the yield is greater. In this connection it is interesting to note that the special climatic requirements of *Hevea brasiliensis* (Para rubber) limits its cultivation to the lower altitudes, and in many instances the tea areas in these altitudes are finding a fuller salvation in rubber, by interplanting with this crop.

Green Tea.—Mention has already been made of the manufacture of green teas in Ceylon. The departure was first made in 1899, and has been continued with considerable success. The export in 1912 was 7,027,000 lb., and while this was less than in 1911 (7,726,000 lb.), the amount was double that of 1910 and nearly twenty times that of 1904. The markets are chiefly Russia and America. The Indian export of green tea in 1911-12 was 4,577,215 lb.

The Cess Fund, established in 1892 for the extension of markets for Ceylon teas, was discontinued in 1908.

Java

In addition to India, Ceylon, and China, Java is the only tea-producing country that affects the English market, the teas of Japan and Formosa being, from the commercial point of view, practically unknown in this country. The successful entry of the Java product into the home market no doubt results from its general resemblance to the teas of India and Ceylon, though the average quality is still admittedly below that of these latter countries. Java at the present time cannot be regarded as a dangerous rival of India and Ceylon, but it must always be borne in mind that a favourable geographical position, a fertile soil, and a low cost of production (consequent upon a good supply of cheap, intelligent labour) are invaluable assets to a country seeking to capture a larger share of a well-established trade.

In point of age, the Java tea industry is much older than that of Ceylon and nearly as long established as the Indian industry itself, to which it shows some interesting historical parallels. Tea (Chinese) was first introduced into Java by von Siebold in 1826, *i.e.* a few years before the despatch of a commissioner to China by the Indian Tea Committee. In 1828–9 the Dutch government assumed control of the potential industry, and established the first definite plantations at Garoet and Buitenzorg, the jat being Chinese. At about the time the Indian government began to dispose of their plantations to private concerns, the Dutch government plantations were let out on the contract system, whereby the finished tea was sold to the government at a fixed price. This system was found to be unsatisfactory since the contractors made every effort to procure large quantities of tea, the quality of the product and the permanent well-being of the plantations being

secondary considerations. Cultivation under this contract system was therefore abolished in 1860.

The modern industry virtually owes its origin to the Dutch tea-man Jacobsen, who, recognising the evils of the contract system, imported in 1852–3 entirely new stock from China and obtained fresh instructors from the same country: much of the older tea in Java at the present time is to be traced directly to these importations. It is remarkable that Jacobsen did not realise the value of the indigenous Indian varieties, for at the date in question they had been known many years, and it was not until 1878 that the "Assam Indigenous" was imported into Java for planting purposes. Since that date, but more especially during recent years, much attention has been given to the replacement of the old Chinese jats by the superior Indian varieties, and with successful results. The seed has been obtained from Assam and Ceylon, and recently supplies have been forthcoming from seed gardens in Java itself.

The chief tea districts are in the western part of the island, but part of the old coffee lands of eastern Java have also been planted up. The principal districts, with approximate number of plantations, are Preanger (200), Batavia (30), Pasoeroean (17), Pekalongan (16), Kediri (14), and Cheribon (7). In the western area the tea is grown up to an altitude of 5,000 ft., but the greater number of plantations lie between 1,500 ft. and 2,500 ft., chiefly on the lower slopes of volcanic mountains. The labour is Javanese, but since the greater part of it is settled on the land and therefore localised, the estates are not necessarily contiguous and do not cover large stretches of country, as in Ceylon and India. On the contrary, they are often widely scattered, being situated near convenient sources of labour.

The climate and soil conditions are, in general, very favourable to tea-cultivation. Java is at about the same distance from the equator as Ceylon, and there is the same continuous growing season as is met with in that island. The rainfall is well distributed in the tea districts, but the best teas are made during the dry months, though the heaviest yields are obtained during the wet season, November to February. From analyses made by Nanninga, it would appear that the soils, while frequently very rich in nitrogen and humus, are often deficient in available potash and phosphoric acid. These facts may be held to explain, in part, two features of Java tea-cultivation, viz. the good average yield (1,000 lb. per acre is not uncommon with Assam jats) and the no more than medium average quality of the finished tea: the abundance of nitrogen and humus should ensure a good crop, while, according to Indian experience, the low percentage of potash and phosphoric acid would militate against a finely flavoured tea. Methods of cultivation and manufacture are in large measure up-to-

date, since Indian and Ceylon progress has been very closely watched. Artificial manures are not yet extensively used, but valuable experiments have been made by the government agricultural experts, and the experience gained in India and Ceylon is being put to good advantage. Bamber states that pruning methods are often indifferent and the plucking coarse, this latter feature being suggested as the chief cause of the second-grade quality of the tea. As regards manufacture, it is remarkable that the Chinese practice of sun-withering is reported to be still employed in some districts, but in other respects the methods are modern in the highest degree, the latest British machinery being used on all the largest estates, and locally made adaptations in the smaller gardens.

Figures relating to the area under tea in Java are not readily available, but the growth of the industry is sufficiently indicated in the official returns of exports :

Year.	Export. *lb.*	Year.	Export. *lb.*	Year.	Export. *lb.*
1884 .	7,029,000	1894 .	8,735,000	1906 .	25,517,000
1888 .	7,479,000	1896 .	9,569,000	1908 .	36,359,000
1890 .	7,062,000	1900 .	15,406,000	1911 .	50,518,000
1892 .	9,000,000	1904 .	25,376,000	1912 .	61,438,000

The most noticeable features in the above table are the small exports of the early years when the industry was far from successful; the rapid increase between 1890 and 1900, and the trebling of the 1894 output in 1904; the remarkable export of 1911, which was double that of 1904; and the 20 per cent. increase in the 1912 export over that of 1911. The most variable statements have been made as to the probable extension of the industry, the maximum output being variously estimated at from 50,000,000 to 90,000,000 lb.; but the figures quoted above clearly indicate the wisdom of abstaining from prophecy on this point. It is officially stated, however, that the type of land in Java best suited for tea is not unlimited in extent, and its value is now rising; while the rubber and other planting industries are making increasing calls upon the labour supply, a factor of obvious importance. Holland is the chief market for Java tea, taking 57 per cent. of the export, followed by the United Kingdom with 37 per cent. Within recent years increasing quantities have been exported direct to Australia, Russia, and China, the last-mentioned country using the product in the manufacture of brick tea. The chief port of shipment is Batavia, with smaller export business at Pamanoekan and Cheribon.

The colonial government has recently offered considerable inducement to the natives to undertake tea-planting, the plucked leaf being sold to the European planters for manufacture, or prepared for the natives in special factories provided by the government. To this

policy the planters are opposed. Apart from certain economic considerations, it is urged that the inferior jats grown by the natives will result in a depreciated reputation for Java teas, and that the unsatisfactory conditions of plant sanitation obtaining in the native gardens will increase the risk of infection in neighbouring European plantations.

China

The widespread consumption of tea among her enormous population renders it probable that China is still the chief tea-producing country in the world, but in the absence of reliable statistics of production and consumption it is

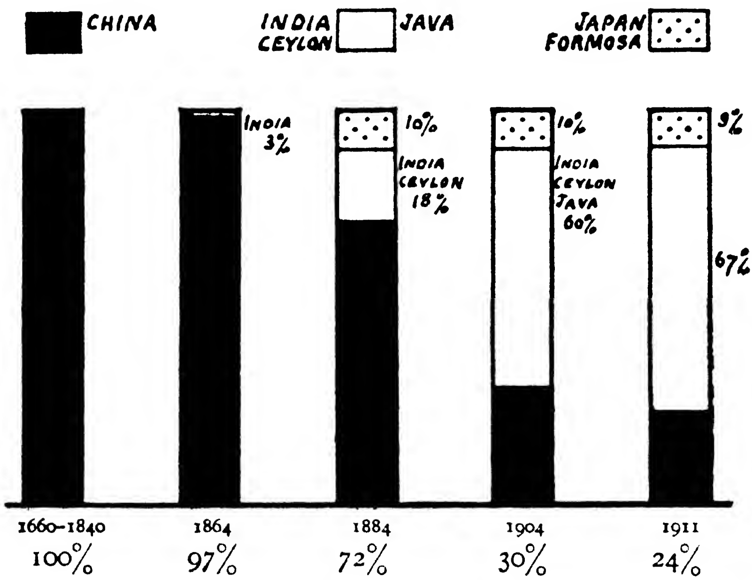


FIG. 9.—*Decline in Exports of Tea from China*, 1660–1911.

difficult to estimate the true position of the industry at the present day.

As regards the export trade, however, the official returns of the Imperial Maritime Customs show that there has been a great decline upon the figures of former years, though the situation is not so serious as might be judged from the fall in the export to the United Kingdom, since China possesses important markets for her tea in other countries, notably in Russia and North America. Even in these latter countries the Chinese and Japanese products have in recent years suffered severely in competition with Indian and Ceylon black and green teas.

The changes in the relative position of China as a tea-exporting country will be seen from the above diagram (Fig. 9). It will be observed that a cumulative

competition has been encountered from three countries, viz. India, commencing in 1840, Ceylon in 1880, and later by Java. Whereas so recently as 1864 the proportion of China tea in the world's exports amounted to 97 per cent., in 1911 it was only 24 per cent.

The relative fall indicated in the diagram (p. 293) is largely due to the rapid expansion in tea production in the tropical East. The actual fall is not so striking: while the maximum export of 2,250,000 pikuls (300,000,000 lb.) of 1886 has never been approached since that year, the following official figures indicate that the export is still of large dimensions:

Year.	Total export. *Pikuls.*	Year.	Total export. *Pikuls.*
1902	1,519,000	1908	1,576,000
1904	1,451,000	1910	1,561,000
1906	1,404,000	1911	1,463,000

One of the few healthy features of the Chinese tea trade is the steadiness of the Russian and Tibetan markets, which constitutes one of the great stays of the industry. Moreover, within recent years the development of the Batoum market, which distributes supplies to western Turkestan and the Transcaspian region, has been of valuable assistance to the China trade: the heavy fall in exports of green teas to the United States in 1911, consequent upon the regulations imposed by that country against the import of faced teas, was nearly balanced by a rapid rise in exports of the same class of tea to Batoum.

The decline in the export trade has been due to three main causes: viz. the change in (British) public taste in regard to tea, the Indian and Ceylon liquors being preferred; the inefficiency of Chinese methods of cultivation and manufacture; and lack of extensive advertisement. So far as the United Kingdom, at least, is concerned, the fact that the methods of manufacture are open to æsthetic criticism has not been without its effect.

The general circumstances of the Chinese industry contrast strongly with those of India, Ceylon, and Java. Practically all the tea grown is raised on small peasant holdings of a few acres or less, and "estates" are almost unknown. The tea season is short, occupying but a few months, and in most districts there are but three or four pluckings a year. Finally, the whole of the manufacture is still carried out by hand, only very simple appliances being used. Many attempts have been made by Chinese and other officials to introduce better methods of cultivation and manufacture into selected areas. In 1905 a Chinese commission visited the tea districts of India and Ceylon, and English machinery has been repeatedly introduced into the country, but no permanent good has hitherto

attended these efforts, in spite of the support given to the movement by native tea-merchants. In regard to the use of machinery, however, it must be pointed out that it is extremely doubtful whether the circumstances of the Chinese industry—notably the short season and peasant proprietorship—render the use of expensive appliances economically possible except perhaps in the final drying in the hongs.

Brief reference may be made to the Chinese methods of manufacture. It is significant that competent authorities declare that Fortune's description, written in 1847, may still be regarded as the best account of Chinese tea manufacture, though the details vary in different districts. In making *black* teas, the plucked leaves are spread out on shallow bamboo trays and allowed to remain for several hours, sometimes in the sun. They are then gathered up in the hands of the workmen, who toss and gently beat the leaves until the latter become flaccid, when they are collected in heaps and allowed to stand for two hours. This may be regarded as equivalent to the "withering" of Indian practice, and it is probable that some "fermentation" occurs. The leaf is then heated for a few minutes in thin iron pans fixed in earth or brick fireplaces, vigorous stirring preventing any possibility of scorching. Rolling on bamboo tables is then carried out by hand, and the leaf later exposed to the air in trays for about three hours, being constantly turned over meanwhile; the roasting and rolling are repeated. During these processes the fermentation takes place, and the action is stopped by heating the leaf in the well-known hour-glass baskets placed over clear charcoal fires, the leaf being removed two or three times for further rolling. Finally the tea is dried off by a prolonged heating, and it is then ready for the middlemen.

In the manufacture of *green* tea the superfluous moisture is removed from the leaf by a short exposure to the air, when firing is at once commenced. The leaves are placed in the iron pans and exposed for five minutes to a very brisk heat, scorching being prevented as before described. They are then rolled and re-rolled, when they are transferred to the pans and dried over a steady fire for one or two hours, when the leaf assumes its soft, silky texture, and the green colour becomes fixed. The finished tea (black and green) is bought from the peasants by middlemen, who transport it to the towns, where the final firing is carried out in hongs. It is at this stage that possibilities for the use of modern machines would appear to be greatest, but the simple native appliances used are said to be not ineffective.

The *facing* or artificial colouring of green teas has long been a feature of the Chinese industry. Such teas are intended solely for export, and much of the most highly coloured kinds, e.g. Pingsueys, have hitherto been sent to

the American market. In 1911, however, this market was officially closed to all faced teas, but no action was taken in China to meet the new situation, a market for the coloured teas being found elsewhere, as stated above. The Japanese government, however, immediately issued an order forbidding the facing of tea. Several substances are used in the colouring process, e.g. gypsum, Prussian blue, turmeric, indigo, and plumbago. The two first mentioned are most commonly employed, and in Shanghai the colouring is effected by thoroughly mixing the tea with a compound of calcined gypsum and Prussian blue (four parts to three parts respectively), in the proportions of 1 lb. of the powder to 200 lb. of tea. The mixing is carried out towards the end of the final firing.

A less objectionable doctoring is the scenting of caper and other teas, chiefly for home consumption or for the Chinese communities abroad. In the preparation of these teas advantage is taken of the well-known property of absorbing odours which is possessed by finished tea, and the fragrant flowers of *Jasminum* spp. ("Mok-lee"), *Gardenia* spp., *Olea fragrans*, and occasionally orange-blossom and roses, furnish the perfume. The flowers, which are collected from trees grown specially for this trade, are moistened and then mixed with the tea in varying proportions (often in separate layers), and the two left in contact for ten to fourteen hours, according to the flower used, the heaps being covered with a cloth. The tea rapidly absorbs the perfume, and when the flowers have been removed is so highly scented as to be unsuitable for immediate use. It is therefore blended with unscented tea, the mixture becoming perfumed throughout. An unfavourable flower harvest results in an immediate rise in the price of such scented teas.

Reference to the brick teas manufactured in China has been made already (p. 281).

The principal tea-producing areas of China are:—for *black* teas: Hupeh, north Kiangsi, Fukien, Kwangtung, and Hunan; and for *green* teas: Kiangsi, Anhwei, Chekiang, Fukien, Kwangtung. Roughly speaking, therefore, the main tea area is in north and central China, with a smaller region in south China. Black and green teas are rarely made in the same district, notable exceptions being Chekiang, producing Pingsuey and Hoochow greens and Wenchow blacks; and Anwhei, with Moyune and Fychow greens and the celebrated Keemun blacks. The nature of the tea (green or black) of any district may, however, vary from period to period, the district now producing black Keemuns producing green teas within living memory.

Japan

Tea is said to have been introduced into Japan from China during the ninth century, and regular cultivation has been carried on for many generations. The principal modern tea areas are in the central and southern parts of the Empire, Shizuoka being the largest and most important district, while the finest teas are grown in Uji. Japanese teas are chiefly greens, and while they are practically unknown in England, the industry is an important one, the total annual production being estimated at about 70,000,000 lb. The area under tea, however, has declined during recent years, owing to the increased interest taken in the mulberry plantations, but the production has increased from 56,000,000 lb. in 1902 to 70,000,000 lb. in 1911. The chief market for the export is North America, chiefly the United States, which takes about one-half of the total production.

The tea is grown in small plots by the peasant farmers, but regular plantations are also common. Much of the crop is grown with considerable skill, and the value of manures (chiefly night-soil, rape-cake, and mulches) is fully recognised. Certain peculiarities in cultural methods, however, call for special mention. The plant is frequently grown in continuous hedges, a few feet apart, and not in separate bushes as in other tea countries, this method often resulting in heavy crops, but rendering the individual bushes very difficult of management from the Indian point of view. It is said that the careful prunings of India and Ceylon, however, are not practised in Japan except at intervals of about ten years, but in place of such treatment the bushes are clipped with shears after the main pluckings; the hedge formation is obviously adapted to such treatment. There are three or four pluckings annually, and the pluck is very coarse, five or more leaves being commonly taken. In the Uji district the remarkable practice of growing tea under artificial shade is in vogue. Bamboo poles are fixed in the fields at regular intervals, and connected at the top by a light framework upon which is placed the matting or straw which affords shade to the growing plants: the system strongly suggests the well-known method of growing special qualities of tobacco under cheese-cloth tents. The shade-grown tea is greatly prized for its quality, and is used entirely for home consumption.

The Japanese industry is concerned almost exclusively with the production of green teas. The methods of manufacture, though primitive, are by no means ineffective, and machines of a simple type are largely used. The first process results in the destruction of the enzyme, the method employed being that adopted in Ceylon, viz. by steaming. According to Bamber and Kingsford, a form of

steamer used consists of a small iron boiler built into a brick furnace about 18 in. square, and fitted above with a metal cylinder provided with a tightly-fitting wooden cover. In the centre of the cover is an aperture 9 in. in diameter occupied by a wire sieve, and the upper part of the apparatus is provided with a cover to retain the steam. The fresh leaf is placed in small quantities on the wire sieve and steamed under close cover for about ten seconds, when it is momentarily stirred and again steamed. The leaf is then thrown on to a tray and cooled by vigorous fanning, which also removes the surplus moisture. A prolonged rolling then takes place, and in this respect Japanese practice departs from that of Ceylon. The object is to obtain a long, wiry, needle-like twist: the leaf is therefore placed in shallow pans set over charcoal fires, and rolled in the pans, by hand, for a prolonged period; it is then turned out on mats and rolled by the feet, when it is again transferred to the hot pans and hand-rolled. Native machinery has been invented to carry out the whole process, but it is stated that the hand-prepared tea is still superior, though large numbers of simple rolling machines are coming into use. It may be suggested that in this remarkable type of rolling two processes are combined: the water taken up during the steaming is driven off by heat instead of being removed in the centrifugal machines as in Ceylon, and there is the rolling proper.

At this stage the tea leaves the hands of the grower and passes, through the middlemen, to the large hongs, where the final firing is carried out. The hongs were formerly in American or British hands, but they are now largely owned by Japanese companies. There are two methods of firing, viz. heating the tea in bamboo baskets held over charcoal fires ("basket-fired" teas), or in iron pans built into brick furnaces ("pan-fired" teas). The former process produces the more valuable product. It is remarkable that European driers have not been used for this final firing, but it would seem that the Japanese apparatus employed is very efficient. In pan-firing, the tea is commonly stirred by hand in the Chinese way, but in many cases the iron pans, arranged in series, are each provided with a mechanical stirrer fitted to a vertical spindle, which passes below into the bottom of the pan, and above is geared to a revolving horizontal shaft driven by an engine. In the lower part of the pan is a trap-door through which the finished tea is discharged.

Formosa

As far as the tea trade is concerned, Formosa is chiefly remarkable for the production of the famous Oolong teas, which are characterised by a quite distinctive flavour. Teas of this character (and name) are also produced in certain districts of China and Japan, but they do not possess the

reputation of the Formosa Oolongs. The principal market for the Formosa product is the United States, and though recently an attempt has been made to popularise the Oolongs in the English market, the trade is still almost exclusively with America.

Considerable mystery hitherto attached to the method of growth and preparation of Formosa Oolongs, largely owing to the relative inaccessibility of the island before the advent of the Japanese. The value of the trade with America, however, attracted the attention of Indian and Ceylon planters, and hopes were entertained of producing British-grown Oolongs that would find acceptance in the American market. It is to this fact that the very full knowledge of the Formosan teas now available is due. Commissioners were despatched to Formosa in 1904 from both India and Ceylon to report on the industry. The results came somewhat as a surprise, for while it was found that the climate and soil of the Oolong districts presented no peculiarities that would account for the special characters of the tea, the methods of manufacture were distinctive; and, above all, the plant concerned was of a special jat quite unknown in India or Ceylon, and one calling for cultural treatment that would render its adoption in those countries out of the question. No practical results, therefore, have resulted from the mission.

There would appear to be eight recognised varieties of tea plant cultivated in Formosa, all of which are under experimental observation by the Japanese Agricultural Department. One, known as *Sité*, produces a tea of poor quality and low value, while the marketable teas are derived from the remaining varieties. The best Oolongs, according to Kingsford and Bamber, are obtained from the *Chishima* and *Peshima* varieties, which are said to offer a very unsatisfactory appearance when compared with Indian bushes, but nevertheless represent about 60 per cent. of the total area under tea.

The most noticeable feature as regards cultivation is that 70 per cent. of the tea grown has been raised not from seed but from *layers*, the remaining 30 per cent. being chiefly old tea. In this cultural practice Formosa differs from all other tea-growing countries, but the reasons for the adoption of such an expensive method of propagation would appear to be conclusive: firstly, little seed is said to be produced by the best tea plants; and, secondly, there is the strongest opinion that propagation by layering is the only method of retaining unimpaired the specific qualities of the tea, deterioration setting in if the plants are raised from seed. The layering is carried out as follows: the soil round the bushes to be propagated is carefully hoed, and the thinner branches are then trodden down flat on to the loose earth. Each branch is then half-

broken through by a smart twist, and the ruptured portion is buried in the soil and pegged down with pieces of bamboo, the soil being afterwards firmly trodden down. In six months there is sufficient root-formation for the layers to be separated from the parent plant, and they are set out when required, one or more layers being used at each "hole."

The special character of Oolong teas is no doubt primarily due to the specific qualities of the plant, but much also depends upon the methods of manufacture. The processes employed appear to be intermediate between those adopted for green and black teas, the essential feature being that although a fermentation occurs it is less perfect than in the case of black tea, since it is carried out before the rolling. The successive stages are briefly as follows:

Sunning.—This stage is often omitted, but when adopted the plucked leaf is exposed to the sun for from twenty minutes to one hour.

Withering.—The leaf is spread out, 3 or 4 in. thick, in large bamboo baskets placed in the shade. The withering is of special character, the leaf being repeatedly turned over and over by hand every fifteen minutes, the whole process lasting from four to five hours. Great importance is attached to the withering, which, next to the jat of the plant, is stated to be the most important factor in connection with the production of Oolongs. There can be little doubt that a "fermentation" is also involved during the withering, for the leaf changes in colour, especially along the edges, and also in odour, the latter affording the criterion for the completion of fermentation.

Panning.—The withered leaf is thrown into iron pans fixed in brick furnaces and made with sloping bottoms. The temperature of the pans is between 360° F. and 400° F., and the leaf is heated for about ten minutes, being vigorously stirred by hand to prevent scorching. The Japanese government are endeavouring to introduce mechanical stirrers of the type used in Japan in the manufacture of green teas.

Rolling.—The panned leaf is then rolled first by hand and then under the feet, the whole operation lasting about ten minutes.

Firing.—This is the final process, so far as local manufacture is concerned. The leaf is placed in hour-glass-shaped baskets of the type so long associated with tea-making, and heated over open charcoal fires made in holes in the ground, over which the lower cone of the basket is placed.

The finished tea is packed into cotton or jute bags, and transported to the hongs, where the sorting, final firing, and packing take place. The centre of this industry is

at Daitotei. The tea is first carefully sorted at the hong, and then fired in baskets placed over charcoal fires arranged in rows of primitive brick furnaces of the type used in the Chinese and Japanese hongs. The drying lasts for from five to twelve hours, and is carried out at a temperature of about 212° F. The tea is finally packed into lead-lined chests for export.

The tea districts of Formosa lie chiefly in the north and north-west of the island, and are in the same latitude as the Foochow and Amoy districts of China, and the Surma Valley in India. The cultivation was introduced into the country in the early part of the nineteenth century by Chinese immigrants from Fukien. Further plants were obtained from China in 1866, but it was not until 1872–80 that planting was carried out extensively. Since the Japanese occupation the industry has received much attention from the government, by whom an Experiment Station has been established at Anpeichin. Most of the gardens are small and owned by peasants, the tea being purchased by middlemen who dispose of it to the hongs. The latter have hitherto been largely held by English, American, and Chinese houses, but part of the business is now passing under Japanese control. The trade is chiefly in the hands of the "Formosa Tea Traders' Association." A large proportion of the tea was formerly shipped to America *viâ* Amoy, but the improvement of the port of Keelung, in northern Formosa, is diverting the trade, and shipments are now made direct. The first export of tea from Formosa was made in 1868 at the instance of John Dod, an Englishman. In addition to Oolongs considerable quantities of scented teas, known as "*Pouchongs*," are made in Formosa, these teas being exported exclusively to the colonies of Chinese in Siam, Malaya, the Philippines, and San Francisco. Pouchongs are prepared from inferior Oolongs, the perfume being imparted by the use of flowers of *Gardenia* sp. and *Jasminum* spp. in the way described for the Chinese scented teas. The business is said to be entirely in the hands of Chinese packers.

Africa

In Africa there are at present but two tea-producing countries, viz. Natal and Nyasaland, the industry in the former being by far the more important. South Africa, with its dry climate and elevated plateaux, does not suggest itself as a tea country; but it will be recalled that the physical configuration of Natal allows of the cultivation of two more or less sharply defined classes of products. In the coastal regions, with a warm and relatively humid climate, several tropical crops, including tea, can be grown; while the highlands are more suited to sub-tropical and

warm-temperature crops, such as maize and wattle. In regard to tea the crop is not cultivated in Natal at altitudes greatly exceeding 1,000 ft., since the climatic conditions would prove unfavourable.

Outside the East, Natal is the only country in the world where tea is grown upon a serious scale. The production is comparatively small, and Natal scarcely figures in the statistics of the tea trade; but the industry is of considerable local importance, the capital invested in it being upwards of £340,000. The production in 1911 was 2,140,000 lb., and returns for previous years are as follows:

Year.	Export. lb.	Year.	Export. lb.	Year.	Export. lb.
1893-4 .	690,000	1903 .	2,681,000	1908 .	2,404,000
1899 .	1,200,000	1904 .	2,576,000	1909 .	2,092,000
1900 .	1,500,000	1906 .	2,376,000	1910 .	2,042,000
1901 .	1,710,500	1907 .	2,200,000		

The area under tea in 1911 was 4,600 acres in full bearing, with an additional 1,400 acres still immature, a considerable reduction upon the area of former years. Kearnsey may be regarded as the capital of the tea-growing district. It is estimated that nearly 10,000,000 lb. of tea could be produced annually if all the land suitable for tea were under cultivation, but at the present time the prospects for such an increase do not appear bright. The industry would appear to be seriously threatened as a result of the local conditions of labour. The labourers hitherto employed have been indentured coolies imported from India, but in June 1911 all recruiting of Indian labour for South Africa was stopped by the Indian government. The greatest difficulty is now being experienced in obtaining sufficient coolies from among those already in the country, since they are attracted to other sections of the labour market. Proposals have been made to recruit negroes in Nyasaland, but the cost would be prohibitive; and it is by no means certain that the negro is adapted to the delicate and intelligent work called for in tea-production. Under these circumstances it cannot be affirmed that the prospects of the industry are satisfactory, and it has been officially stated that there is little likelihood of progress, or even a maintenance of the present scale of operations, until the labour problem is solved. Another economic factor must also be borne in mind. Natal depends almost entirely upon the South African market for the disposal of her tea, which benefited to a considerable extent from the operations of a protective tariff. A recent reduction in these benefits has affected the planters, for Natal teas, in the average grade, while

of good quality, cannot compete with the better grades of Ceylon and Indian produce.

Several attempts have been made to introduce South African tea into the English market. The most recent was that resulting from the analyses of samples shown at the South African Products Exhibition in 1907. The analyses were carried out at the Imperial Institute (this BULLETIN, 1908, **6**, 1), and the samples are on view in the South African Court of the Institute. The immediate object of the investigation was to establish a comparison between the teas of India and Ceylon and those of South Africa. Briefly, the results went to show that Natal teas show a general similarity to Indian teas, as would be expected from the fact that the original seed was obtained from India. In the case of a series of grades prepared on the Kearnsey Estate, all the teas were good black teas combining the special qualities of Indian and China teas; the percentage of caffeine varied from 3·1 to 3·9, and the "tannin" content was low, varying from 6·3 to 7·8 per cent. As a result of this report, Natal tea was placed on sale in London, and is obtainable from the West Indian Produce Association, Ltd.

The history of tea-planting in Natal has, in certain respects, a close resemblance to that of Ceylon, for both were established as a result of a failure in coffee. In the first half of last century, coffee was an important crop in Natal, but between 1870 and 1880 a succession of misfortunes overtook the industry in the shape of repeated bad seasons, attacks by fungoid and insect pests, and a general fall in prices. Attention was thereupon directed to tea, for, although tea had been manufactured in Natal as far back as 1862, no serious attempt at an industry had been made. Seed was obtained from India, "Assam Indigenous" and "Hybrid" being the varieties selected. For some years little success was experienced, as a result of drought and insect pests, but plantations were finally established, and in 1883 a sample of tea from the Kearnsey Estate was valued in London at 2*s.* 9*d.* per lb. Two years later tea was being manufactured on a commercial scale, and the number and area of plantations rapidly increased.

In Nyasaland, tea has been grown on a single estate for some years past, the production, in great measure, being consumed locally. In 1908–9, however, tea figured for the first time in the exports, the amount being 24,000 lb., valued at £600; while in 1911 the quantity was practically doubled, 44,000 lb., valued at £1,100, being exported. The production for 1912 is estimated at 175,000 lb. The acreage under the crop is still very small, being no more than 2,593 acres, but there has been an interesting growth of the industry, as will be seen from the following figures:

Year.	Acres.	Year.	Acres.	Year.	Acres.
1902 .	. 12	1906 .	. 395	1910 .	. 518
1903 .	. 127	1907 .	. 445	1911 .	. 1,200
1904 .	. 260	1908 .	. 516	1912 .	. 2,593
1905 .	. 260	1909 .	. 598		

Practically the whole of the area is confined to the hot, damp valleys on the southern and south-eastern slopes of Mlanje Mountain, where the rainfall averages 70 to 100 in. per annum, but other localities, viz. Cholo, M'penda and districts of West Nyasa, possess climatic conditions favourable to tea-growing, and satisfactory experiments have been carried out at Zomba. It is expected that tea will eventually prove an important minor industry of the country, but the cultivation can never attain to large dimensions, since suitable areas are not extensive. The plants are of Indian origin, and so far have grown well and escaped serious attacks from insect or fungoid pests. Until recently, locally-made appliances have been used in the manufacture of the tea, but machinery has now been imported. As regards the quality of the tea, it may be said that samples graded as "Orange Pekoe," "Broken Mixed," and "Dust Fannings" have been valued by a leading firm of brokers at from 7½*d.* to 5¼*d.* per lb. (1904), and a chemical analysis of the same samples, carried out at the Imperial Institute, confirmed the brokers' conclusions that the teas were of good quality. Very satisfactory prices have been quoted since that date in London and elsewhere.

Experiments in tea-growing have recently been carried out in two other British Protectorates in Africa, viz. Southern Nigeria and Uganda. In the former, seed imported from India has been raised at Onitsha by the Agricultural Department. Analyses of the manufactured product at the Imperial Institute (this BULLETIN, 1912, **10**, 395) showed that it possessed a general resemblance to Indian tea, and brokers valued two samples at 9½*d.* and 10½*d.* respectively (May 1912). No report is as yet available regarding the Uganda tea, but the plants are stated to be doing well.

Russia

As is well known, a small but prosperous tea industry has been established for some years in the Caucasus under Russian Imperial control. The climate of the area is said to compare favourably with that of south-eastern China, and is in many ways suited to tea, there being a fairly well distributed rainfall of about 96 in. per annum; the severe winter and hot summer, however, are inclined to have deleterious effects upon the plants. The industry was started with some considerable success by M. Solotzoff about twenty-five years ago, but the present Imperial

plantations were laid out in the early nineties of last century, the factory being built in 1898. A commission was appointed to visit the great tea-producing countries of the East in order to gain information as to cultivation and manufacture, and for the first few years the plantations were under the charge of an Indian planter, who was supplied with Chinese labourers. At the present time the industry is solely in Russian hands, and the Chinese have been superseded by the local peasantry. The acreage in 1911 was about 1,620 acres, of which only part is as yet in full bearing, and it is estimated that 200 additional acres are opened up each year. The principal plantations are near Chavka, on the Black Sea, about four miles north-east of Batoum. The Imperial estate is said to be well managed, and the cultivation is being carried out on modern lines, but manuring is not yet practised. Indian, Ceylon, Chinese, and Japanese jats have all been experimented with, but, as would be expected from local climatic conditions, Indian and Ceylon plants are not well suited to the country, and the Chinese varieties are found to do best. The bushes are planted 3 by 3 ft. or 3 by 2 ft., and there are four or five pickings annually, the first yielding the best-quality tea, but the second a larger crop. A heavy pruning is carried out in the autumn. In regard to manufacture the methods would appear to be quite modern, the factory being equipped with up-to-date machinery, chiefly of British make.

There are several smaller private tea gardens near Chavka. The crop is too small to warrant the erection of separate factories, and the leaf is taken to the Imperial factory for manufacture. Messrs. Popoff, of Moscow, also possess an estate of about 320 acres near Batoum and a smaller plantation near Chavka. The total crop of the Caucasus amounts to about 200,000 lb. per annum. The tea resembles British-grown tea in flavour, but, judged on this basis, is of somewhat inferior quality. It is mostly consumed in Central Asia and in Poland, and though experimental shipments have been made to America on several occasions, no permanent trade has resulted.

Other Countries

The value and importance of the tea trade has resulted in repeated attempts at tea cultivation in almost every country possessing the requisite climatic conditions. Many of these efforts were quickly abandoned, and others have not advanced beyond the experimental stage, while in a few instances small cultivations have been established. The most interesting of these latter is the American plantation near Somerville, in South Carolina.

Tea-growing in the United States has been the subject of experiment for nearly three-quarters of a century. The

first attempt was made in 1848, when plants were raised at Greenville, South Carolina, but without permanent result The matter subsequently received attention at the hands of the government, and Fortune was despatched to China in 1858 to obtain seed, the plants raised therefrom being distributed to many parts of the Southern and Gulf States. Small quantities of an excellent tea are said to have been manufactured at Somerville, South Carolina, in 1880, under the superintendence of an Indian planter, but the experiment was abandoned.

At the present day there is only one tea plantation in working order, an area of about 50 acres being under tea at the Pinehurst Estate, Somerville, S.C. The plantation is the outcome of private experiments started in 1889, but within recent years the work has been under government supervision. The experiment has been planned on thoroughly sound lines. Several varieties of tea (Chinese, Japanese, Indian, and Ceylon) have been planted up under varying conditions of soil and situation, and the results have been quite satisfactory. The "Darjeeling" and "Chinese" varieties are said to be best suited to the climate, and seed from high altitudes in Ceylon is successful. The yield varies from 253 to 412 lb. per acre, according to the variety of tea and the situation of the "garden," and it is stated that a yield of 250 lb. renders tea-growing a commercial proposition. Both black and green have been manufactured, modern machinery being employed, and the product is of fair quality.

The experimental plantation at Pierce, Texas, has recently been abandoned by the government.

In Jamaica, "Hybrid" and Assam teas were planted by the Botanical Department in 1885 and 1886, supplies being obtained through Kew. Small quantities of tea were manufactured from time to time, and in 1896 the cultivation was definitely undertaken and suitable machinery employed. In 1911 there were 80 acres under this crop. The tea was first put on the market in 1903, and samples may be seen in the Jamaica Court at the Imperial Institute. Considerable areas of land on the slopes of the Blue Mountains are said to be suitable for tea-cultivation.

Tea has also been grown in several localities in Malaya. Tea of good quality can be grown in Perak (Federated Malay States), but the difficulty of obtaining labour in face of the competition of the tin mines has prevented the development of the industry. In Malacca (Straits Settlements) a Chinese estate produces a tea of fair quality.

The product grown in the French colony of Annam has already been mentioned.

Attempts at tea-growing have been made in Portugal, Brazil, and the Azores. Tea seed sent to the King of Portugal from the Emperor of China was raised in Brazil

with some success, and the possibility of cultivation in that country has been seriously considered on several occasions. A definite industry was established in the Azores (San Miguel) in 1840, and tea is produced in small quantities in the Ponta Delgada province. British machinery has been imported.

Small quantities of tea have also been grown in Mauritius, Fiji, and the Andamans.

II.—THREE LECTURES ON COMMERCE IN TEA

By John McEwan, F.R.G.S.

The following is a summary of the lectures on "Commerce in Tea," given by Mr. John McEwan, F.R.G.S.

As regards the historical aspect of the subject, although a great deal has been written from time to time in the course of the tea trade, the history of tea has not yet been fully recorded. In fact some of the good things which have been written have taken the shape of advertisements which have been published by private firms. There are, however, tea histories belonging to Russia, a country whose connection with tea, although not so extensive in volume as that of the United Kingdom, has been longer and closer. The Russian authorities have followed a somewhat different policy from that of the authorities of the United Kingdom, in encouraging commerce, in fostering it, and then in allowing it to be developed by individual traders in their own way. In consequence, at St. Petersburg certain men have had a good deal of financial encouragement in order to study the history of tea and also its cultivation. In particular, Dr. Andreas Krasnoff, Professor at the University of Kharkoff, spent about two years in China, Japan, India, and Ceylon, and devoted himself to a thorough and exhaustive study of all matters relating to tea production. He was sent to do this by the Russian authorities, who thought that they could grow tea and other products successfully in the Caucasian regions. There was also another authority on tea—Mr. Winimitimoff, a Russian, who had a very close connection with the history of tea in the recent past, and from these friends Mr. McEwan obtained much information.

Almost the entire production of tea in the world is grown within an area confined by 40° of latitude and 60° of longitude; the boundary lines being about 32° N. and 8° S. latitude, and 80° E. and 140° E. longitude. Excluding China and Japan, about which no statistics are available, the principal tea-drinkers are the peoples of the United Kingdom, British Colonies, Russia, and the United States of America. Excluding China and Japan, the world's consumption may be taken roughly as 700,000,000 lb. per

annum; this, including the cost of transport to the countries of consumption, but excluding revenue duties and profits of distribution, may be valued at about £25,000,000.

History.—The use of tea as a beverage seems to have originated in China. An account of its production in that country, and the advantages and disadvantages of its use, are given in the story of a journey through China by Louis Le Comte, a Jesuit priest. A second edition of this work was published in London in 1698, and shows that tea must have been in extensive use in the middle of the seventeenth century, especially in China. China must have had an export tea trade over a very long period, but it was probably a very small one, because there is no trace of it in Europe in the early days. There is none in the eleventh and twelfth centuries, and none in the old Hansa cities; so that in all probability the Russians were the earliest traders in it. The first treaty between Russia and China was made in 1590, but it contains no mention of tea; the Chinese Embassy, however, in 1618 carried some chests of tea as presents to the Russian Court of the Czar Alexis, at Moscow. These, travelling overland through Siberia, took eighteen months to complete the journey. England commenced to use tea about the middle of the seventeenth century; it was then carried by Dutch traders from Java, and reached England indirectly. The Russian Court took a liking to tea after receiving the present in 1618; and the Czar Alexis sent a special messenger yearly to the Chinese frontier to obtain a supply. The Empress Elizabeth in 1735 established a regular trade, and Russian merchants bartered cloth, furs, etc., for tea: at that time a pound of tea was sold for 15 roubles, which, allowing for the depreciation in the purchasing power of money, is equivalent to about £6 now. Trade gradually increased, and a regular caravan route from China was established. Mules and horses carried the tea for 150 miles over mountains to Kalgan, thence camels transported it over 800 miles of the Gobi Desert to Urga. It was again carried by horses for 200 miles, and then followed the route of the present Siberian railway from Kiakhta to Cheliabinsk. The journey took some sixteen months to Moscow. There has been no caravan trade for the last thirteen years, owing to the completion of the Siberian railway. To-day 70 per cent. of the Russian trade goes *via* Vladivostock and thence by rail across Siberia; the remaining 30 per cent. goes *via* the Suez Canal and the Black Sea. The time now taken is one month from Hankow to Vladivostock by steamer, and then three weeks to Moscow by train.

Before the coming of the Siberian railway an attempt was made by Capt. Wiggins to open up an all-water route to Asiatic northern ports. Brick tea was brought by sea from China to London, where it was transhipped into

steamers which went round the north of Norway to the Kara Sea and then into the Obi and Yenisei Rivers. The journey, though about seven times as long in mileage as the caravan route, took only about four months, and was much less expensive. On the whole, however, the dangers and difficulties encountered were too great for it to be successful: twice the cargoes had to be brought back, as they could not be landed.

Turning now to the history of the English tea trade, the earliest record of tea being mentioned by an Englishman was probably that contained in a letter from Mr. Wickham, an agent of the East India Company, written from Firando in Japan on June 27, 1615, to another officer of the company, resident at Macao in the south of China, asking him for "a pot of the best sort of chaw." It was not until the middle of that century that the English began to use tea; they received their supplies from Java until 1686, when they were driven out by the Dutch. At first the price in England ranged from £6 to £10 per lb. In the *Mercurius Politicus* of September 1658 occurs an advertisement of the "China Drink called by the Chineans Tcha, by other nations Tay, alias Tee," being sold in London. Thomas Garway, the first English tea-dealer, in 1659 or 1660 offered it at prices varying from 15*s.* to 50*s.* per lb. In 1660 an Act of Parliament imposed a tax of 8*d.* on every gallon of tea made and sold. Not until 1677 is there a record of the East India Company having taken any steps for the importation of tea. The annals of the company record that in February 1684 the directors wrote to Madras, "In regard thea is grown to be a commodity here . . . send us yearly five or six canisters of the very best and freshest thea." The first direct purchase in China was made at Amoy, the tea previously obtained by the company's factors having been purchased in Madras and Surat, whither it was brought by Chinese junks after the departure of the British from Java. During the closing years of the seventeenth century the amount brought over seems to have been, on the average, about 20,000 lb. a year. As the eighteenth century progressed the use of tea in England rapidly increased.

During the nineteenth century there was a fairly regular progression in the volume of consumption within the United Kingdom. In 1836 the annual rate had reached 40,000,000 lb.; in 1850, 54,000,000 lb.; in 1860, 78,000,000 lb.; in 1870, 120,000,000 lb.; and in 1880, 160,000,000 lb. The import of tea was originally a private monopoly of the East India Company, and a very profitable one, but this ceased in 1833. At that time the teas in use were principally green teas, and of the highest quality, and they were sold at rates prohibitive to a large portion of the people; the supply of teas of such quality as the East India Company provided

being limited, led to the fabrication of spurious mixtures and coloured teas to meet the public demand for green teas. Small factories were established in London for the manipulation and colouring of leaves of willow, sloe, and elder, and for the collection of spent leaves. Sand and mineral substances were sometimes added. Parliament took action by passing the "Adulteration Act."

At the present time intentional adulteration is almost non-existent in the places of production, for the reason that the price obtained is so low that any possible adulterant is too costly to collect. Further, all tea imported as merchandise into the United Kingdom is subject to careful examination by inspectors, and in all doubtful cases samples are taken and analysed. If the samples are found to be mixed with other substances, or with exhausted tea, the importations represented by the samples can only be delivered with the sanction of the Commissioners of Customs and Excise, and on such terms and conditions as they direct. If the tea is unfit for human food, it may be forfeited and destroyed or otherwise disposed of at the discretion of the Commissioners; such tea is only allowed to be delivered for use in the manufacture of caffeine. In the case of exhausted tea, or tea mixed with other substances, the importer is usually given the option of exporting it under bond. During 1912, 347,732,433 lb. of tea were imported and inspected by surveyors of Customs and Excise, and 12,731 samples were drawn and analysed; of these, 11,627 were passed, and of the remaining 1,104 (representing 2,553 packages, or 256,603 lb.), 301, representing 1,249 packages, were condemned as unfit for food. Of these last, however, 358 packages had been imported for use in the manufacture of caffeine, and not for consumption. The net result is that there were only 891 packages, or say about 90,000 lb. out of the 350,000,000 lb. condemned as unfit for consumption—equivalent to less than 0·03 per cent.; this included all sea damages, country cake, and dusts with mineral particles.

Before leaving the history of the trade, reference should be made to the famous China clippers of the fifties and sixties (nineteenth century), which raced with the new season's growth to England. They were little more than yachts in their model, build, and sailing capacity. The discovery of gold in Australia caused a great demand for goods to be sent there; these occupied a great deal of space on the ship, whilst the gold exported in payment occupied next to none. The China clippers could thus carry cargo to Australia, proceed to China, and return laden with tea. There was keen competition to get loaded up with tea, make a rapid passage, and bring the first tea of the season to England. In 1866 three ships left Foochow together, made the voyage of fully 16,000 miles in ninety-nine days, and were docked in

London within two hours of one another. Another ship made the voyage from Foochow to London in ninety days, and this is the fastest on record. The opening of the Suez Canal in 1869 soon changed the course of all trade with the East, and sailing-ships gave way to steamers. In 1882 a steamer made the run from Woosung, near Shanghai, to London in twenty-eight days, and that record has not yet been beaten, because the demand for speed has lessened, and no one cares in particular now for new season's teas in preference to others.

Brick Tea. — Brick tea is quite an ancient article, and doubtless arose originally from the absence of roads in China. When tea was carried on men's backs instead of on horses, of which there were none in the tea-growing districts, it was an advantage to have it in as condensed a form as possible. The trade spread, and bricks were made for the trade in Mongolia and Manchuria. Somewhere about 1850 the Russians began to come to Hankow, and started buying teas, at first only Congou, a black, large leaf tea; later they bought brick tea. In 1861 they started the first brick-tea factory in Hankow. The bricks were made at first under lever pressure by man's weight, then followed steam machinery, and later, in 1878, a factory using hydraulic pressure was built there and was a great success. Originally bricks were made there to use odd lots of dust, then better quality was wanted, and tea was milled down for the purpose. The tea-dust is placed in canvas covers and compressed in wooden moulds. Tablet tea is another variety in which whole-leaf Congou is compressed. One advantage of the brick form is that the quality and character of the tea are better preserved. Tea is easily spoilt by access of air and moisture, or of odours from other materials, so when loose it must be kept in hermetically closed receptacles, if it is to retain its quality. The same result is obtained by making it into bricks, as then only the outer surface is exposed to the air. The use of brick tea spread to Tomsk, then from 1890 to 1900 it extended to Eastern Europe, and it is now across the Volga. As the trade extended westward superior quality was demanded, and now some kinds are sold that are even dearer than the Congou or uncompressed whole-leaf. In recent years the use of Indian, Ceylon, and Java dusts for brick tea has greatly increased. Efforts have been made to introduce consolidated tea into England, but without any great success; but a tabloid tea made by a firm which puts up all kinds of tabloids commands a certain amount of trade at foreign stations.

Another great export trade in brick tea from China must be mentioned, namely that going to Tibet; the bricks are of a totally different nature from those prepared at Hankow for Siberia. They are made at Ya-chou and

Ta Chien-lu in the Szechwan province from exceedingly rough leaf, including even bush prunings, and are packed in hides sewn up while moist, which, on contracting, make a strong, tight package of 60 to 70 lb. weight. These packages are carried by coolies across the high passes into Tibet.

Japanese and Formosan Teas.—The Japanese production is almost entirely green tea for North American use, but the industry is declining owing to a change in the American taste, and the area under tea has diminished by 20 per cent. since 1896. The export production of Formosa is limited to a particular class of tea termed Oolong, practically all produced for the United States, and scarcely known in England except by experts. The Tea Cess Committees of India and Ceylon have both sent representatives to study its growth and production, but so far neither country has made a successful attempt to produce commercially tea of this class, which, in its finest qualities, is characterised by a delicacy and bouquet possessed by no other tea.

Arrival, Sale, and Distribution.—When tea comes into the Port of London it passes immediately into the control of the Customs, and after landing until weighed it remains under watch. Even when passing through the streets to a warehouse or to another ship, the Customs keep guard on it, and a "cart follower" watches it on its journey. It is placed in a bonded warehouse for storage and the necessary operations, and can only be removed from there on payment of the duty or for re-exportation. Here it is also inspected as to fitness for consumption, as explained above. The warehouses are in the neighbourhood of Mincing Lane, or in the vicinity of the City, or on the riverside. In the matter of sales, "Mincing Lane" is a general term, used to include all the produce markets; in the case of tea it includes Fenchurch Street and some other streets. The tea is sold by auction in the London Commercial Sale Rooms.

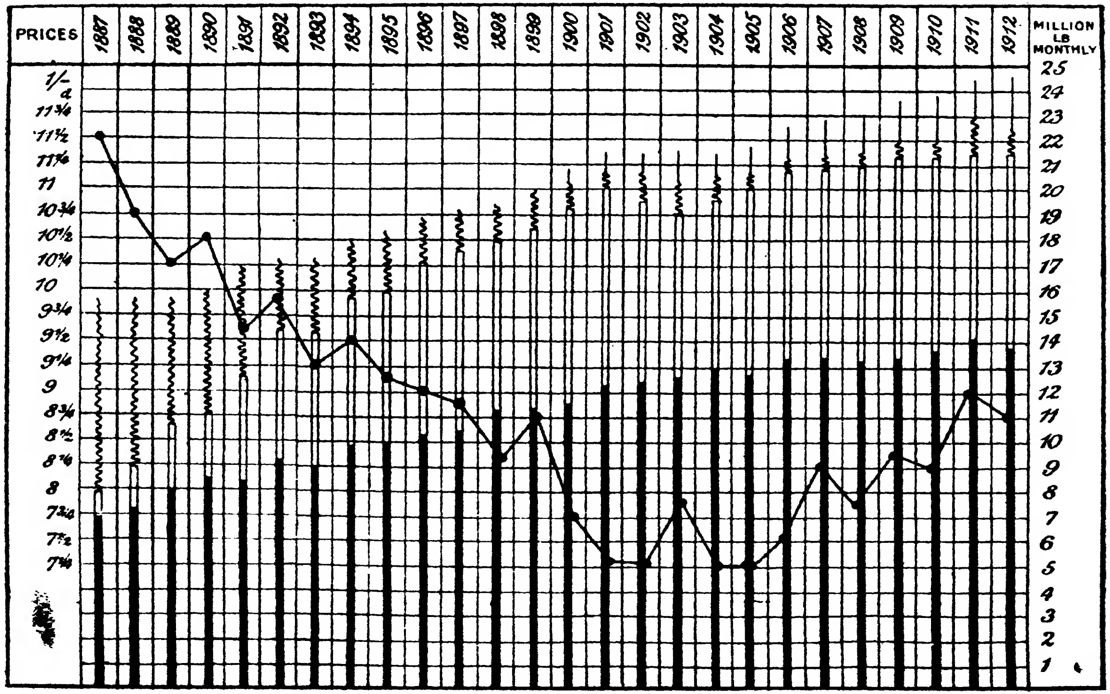
Sales are conducted by the issue of sale catalogues, in which all the teas on sale and all necessary particulars are inserted; and with the possession of a sale catalogue samples can be obtained by those who are authorised to draw such at the public bonded warehouses. A very large staff of employees is necessary to draw what are called sale samples—a sample of every lot of tea put on show to the trade; and the auction sale work is very arduous. Thus, in 1912, in one week the auctions of Indian, Ceylon, and Java teas amounted to 102,000 packages, and involved an enormous amount of work to those in the warehouses and sale-rooms. The persons employed in the tea trade may be classed in six sections: (1) the importer or merchant; (2) the warehouse-keeper; (3) the broker; (4) the wholesale dealer; (5) the country dealer; and (6) the retailer.

The bonded warehouses for the tea trade and other trades are a strong feature of our method of collecting part of the taxation of the country, but there are other methods; thus in Germany the Frei Haven of Hamburg is a system which answers very well, and if something like it could be established in London it would make for economy, but it would be very difficult to arrange. The warehouse-keepers undertake, for a uniform and inclusive charge, a number of duties, including landing, lightering or railing, wharfage, housing, weighing, furnishing landing weights, examining and turning out and in for damage, mending, laying down for private inspection, lotting, nailing down, also laying down for public sale, attendance while on show, and other consequent operations, and delivery, including merchants' sampling and making out warrants.

The wholesale dealers employ salesmen, who are the London travellers, whose business it is to hunt up purchasers; they have to be diplomatists, and have to smooth over all manner of difficulties, and persist, notwithstanding the discouragement of failing to effect sales after all their efforts. Tea-tasters are also employed in the dealer's sale-room, for whom many qualifications are necessary. A successful tea-taster has to possess the gift of judging by taste, sight, touch, and smell, and, further, the memory of previous transactions and of the best places for selling particular kinds of tea. Thus a tea might sell for much more in one market than it would in another, the difference arising from the nature of the water. A taster requires many years of training before he becomes an adept in his work. He employs in the tasting-room scales, cups, pots, kettles, stoves, time glasses, all carefully standardised, and the operations of infusion for five minutes, six minutes, or ten minutes, are conducted most carefully to ensure uniformity.

The wholesale dealer at one time was the prince of the trade, but now his chief function may be said to be giving credit to those who have not got money. He supplies the retailers of London and the country wholesale and retail, and does a certain amount of export trade. The country dealer is a wholesale dealer on a smaller scale who frequently gets credit and sells the tea to small customers throughout the country. The business of the wholesale dealers has been encroached on by the operations of the "syndicate retailer" or "multiple shop" trade, that is by those companies that control numerous retail shops selling tea and other commodities. Such firms have enormous power as buyers, and having no difficulty in re-selling their purchases have great freedom for buying at certain times. Most of them have buying arrangements in the countries of production, and some even are producers. Thirty years ago all the trade passed through the books of the wholesale dealer, but

Statement showing the alterations in the relative proportions of different growths of Tea consumed in Great Britain and Ireland during twenty-six years ended December 31, 1912, *the variations in the London average prices for Indian Teas, the changes in rate of Duty, and the rate of Consumption per person of the Population.*



	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899
Consumption of all Tea per person of Population within the United Kingdom	lb. 5·02	lb. 5·08	lb. 4·99	lb. 5·17	lb. 5·36	lb. 5·42	lb. 5·41	lb. 5·53	lb. 5·67	lb. 5·73	lb. 5·81	lb. 5·85	lb. 5·98
Percentage of each kind consumed within the United Kingdom — Indian	44⅓	46¾	51½	52	48¾	53¼	52	54½	53½	54	54	57	55½
Ceylon	6	10¼	15¼	17¾	24¾	30¼	31½	33	32½	35½	36¾	34½	35
Java	—	—	—	—	—	—	1	1	1¾	1¾	1¾	2	2¾
China	49⅔	43	33¼	30¼	26½	16½	15½	11½	12¼	8¾	7½	6½	6¾
TOTAL ...	100	100	100	100	100	100	100	100	100	100	100	100	100
Rate of British Duty per pound.	6d.				4d.								

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Consumption of all Tea per person of Population within the United Kingdom	lb. 6·07	lb. 6·16	lb. 6·06	lb. 6·03	lb. 6·00	lb. 5·98	lb. 6·17	lb. 6·21	lb. 6·18	lb. 6·37	lb. 6·39	lb. 6·46	lb. 6·45
Percentage of each kind consumed within the United Kingdom — Indian	55	57½	58½	59¼	60½	58	59	59¼	57¼	56½	56½	57½	56
Ceylon	37	36	33½	30¾	31	34½	34	31¾	33¾	33½	32½	30¼	31¾
Java	2½	2¾	3½	4¼	4¼	5	5	5½	5¾	7	7½	7¼	8¾
China	5½	3¾	4½	5¾	4¼	2½	2	3½	3¼	3	3½	5	3½
TOTAL ...	100	100	100	100	100	100	100	100	100	100	100	100	100
Rate of British Duty per pound.	6d.			8d.	6d.	5d.							

Vertical lines show the average *monthly* consumption in Great Britain and Ireland in millions of pounds, subdivided into four growths, as follows:—

Indian. Ceylon. China. Java.

The diagonal line shows the average price per lb. of all *Indian* Tea sold at the London Public Auctions.

now he has become little more than a broker for a bare percentage if his clients can pay cash, or a sort of banker if they need credit.

Influence of the Water.—The nature of the water used has a considerable influence on the palatability of the infusion, and different teas suit different waters. Distilled water is quite the worst for producing a pleasant beverage. The waters of Moscow and of Belfast produce remarkably good tea. Sometimes buyers coming to London bring casks or jars of their local water with them to test the tea.

Blending.—The blending of tea so as to suit all demands for price and quality is an important development of the trade. Great skill is necessary in combining different teas to suit different districts and the water in use in them. Several tea-blenders have built up enormous businesses and employ complete systems of labour-saving machinery. The blending that was formerly done by retailers with shovels on a wooden floor is now done in immense rotating drums which thoroughly mix the selected components. It is sometimes necessary to cut the teas into smaller pieces before mixing, and this is done by special machinery. The blended tea is put into packages of different sizes to suit the needs of the buyer, or else it is made up into packets by elaborate machinery which is fed with tea and paper wrappers and delivers well-formed paper packets filled, labelled, and sealed ready for despatch.

The Tables.—The table on pp. 314–315 shows the relative amounts of Indian, Ceylon, China, and Java teas consumed in the United Kingdom in the last twenty-six years, and the same information expressed in percentages; it also gives the average London prices for Indian teas, the rates of duty, and the consumption per head over the same period. Until 1860 there was no other tea than China tea; even by 1870 India gave only some 14,000,000 lb., while China tea was steadily increasing. By 1880 China had reached her maximum of 126,000,000 lb., and India was giving us 45,000,000 lb. The year 1887, where the table begins, was the point where India obtained the ascendancy which she has never lost since. Ceylon came rapidly to the front, largely displacing China tea, and within seven years reached the point where she stands to-day.

The table on pp. 317–319 gives the total consumption of tea by different countries, the consumption per head of the population, and also the rates of duty. As regards consumption per head New Zealand heads the list with 7·45 lb., Australia and the United Kingdom following her close. In the matter of duties the colonies have all made tea a free article with certain reserves: in the case of Australia the idea is to protect local labour by taxing small packages; New Zealand follows her in this, and also tries to keep out Java and China tea and to encourage that from South Africa.

Consumption of various Countries, as shown in the latest obtainable Official Figures; also Rates of Duty charged (sterling equivalent)

	Total consumption per annum.	Rate per person of population.	Rates of duty per lb. as they stood on April 1, 1912; taken from the Official Returns published in India.	
	lb.	*lb.*		
United Kingdom	295,275,000	6·45	. . . .	5*d.*
Russia . .	147,132,000	0·90	1. Imported by the European Frontiers:	
			Brick tea (black or green)	8*d.*
			All other kinds . .	1*s.* 10¾*d.*
			2. Imported by the European Frontiers or the Black Sea:	
			Tea of Ceylon or Indian origin	1*s.* 10¾*d.*
			3. Imported across the frontier of the Semiryechensk Province of the Steppes, Irkutsk, or the Amur:	
			Black bohea, flower green and yellow .	1*s.* 6*d.*
			4. Imported into the Amur and the Trans-Baikal region of Irkutsk:	
			Brick tea . . .	Free.
			All other tea . . .	1*s.* 6*d.*
			5. Imported through the customs house of Irkutsk or westward across the frontier of Siberia or of the Steppes, or the Semiryechensk:	
			Tea in bricks . . .	2⅝*d.*
			Tea in tablets of Russian manufacture . .	10⅝*d.*
United States .	83,298,000	0·89	. . . .	Free.
Canada . .	34,259,000	4·34	Tea imported direct from the country of growth and production, also tea purchased in bond in the United Kingdom	Free.
			All other tea, *ad valorem*	10 %
Australia . .	29,517,000	6·83	In packets not exceeding 20 lb. in weight	1*d.*
			All other tea . . .	Free.
New Zealand .	7,244,000	7·45	Tea in packages of 5 lb. or over, net weight of tea:	
			If the produce of some part of the British Dominions . . .	Free.
			Otherwise . . .	2*d.*
			Tea in packages of less than 5 lb.:	
			If the produce of some part of the British Dominions . . .	2*d.*
			Otherwise . . .	2½*d.*
			Tea being the produce of and being imported from the Colony of the Cape of Good Hope, the Colony of Natal, the Orange River Colony, the Transvaal, and Southern Rhodesia	1*d.*
Carried forward	596,725,000			

	Total consumption per annum.	Rate per person of population.	Rates of duty per lb. as they stood on April 1, 1912; taken from the Official Returns published in India.	
	lb.	*lb.*		
Brought forward	596,725,000			
Germany	9,124,000	0·15	For consumption as tea	5⅓*d.*
			For the manufacture of caffeine	Free.
France	2,774,000	0·07	Imported directly from a country out of Europe	9*d.*
			Imported from European entrepôts	11¾*d.*
Holland	12,377,000	2·07	. . . .	2¼*d.*
South Africa	7,145,800	1·20	Tea the produce of South Africa or tea grown within the South African Colonies Union	Free.
			Other tea	4*d.*
Argentina	3,747,000	0·62	. . . .	4⅛*d.*
Tibet. about	20,000,000	—	. . . .	—
India	25,722,000	—	. . . . Free, if grown in country; but 5% *ad valorem* on an artificial valuation if imported, black tea being reckoned at 11 annas and green at 9 annas.	
Burma about	18,000,000	1·5	. . . .	Free.
Persia	7,918,000	0·83	White tea (a special tea grown in Java)	7*d.*
			All other tea	4½*d.*
	703,532,800			

Rates of Duty (in sterling equivalent) of various Countries

Austria-Hungary, imported by sea		9¾*d.*
imported by land		11*d.*
Bahamas		6*d.*
Barbados		3*d.* and 20 % *ad valorem.*
Belgium		Free.
Bermuda	*ad valorem*	6¼ %
Brazil	*ad valorem*	50 %
British East Africa	*ad valorem*	10 %
British Guiana		8*d.*
Bulgaria		4¼*d.*
	plus excise	4¼*d.*
	and octroi	1¼*d.*
Ceylon	Free if grown in country, but if imported	4*d.*
Chile		8¼*d.*
China	*ad valorem*	5 %
Cyprus		1½*d.*
Denmark		4¼*d.*
Ecuador		2½*d.*
Egypt	*ad valorem*	8 %
Fiji		6*d.*
Gibraltar		Free.
Greece		1¾*d.*
Grenada		6*d.*
Honduras		3½*d.*
Italy		11*d.*
Jamaica		1*s.*

Japan, black tea	$4\frac{1}{8}d.$
black tea dust	$1\frac{1}{4}d.$
other tea	$1\frac{1}{10}d.$
Lagos	1*d.*
Malta	Free.
Mauritius	3*d.*
Mexico	6*d.*
Morocco	*ad valorem* 10 %
Newfoundland	Free.
Nigeria	1*d.*
Norway	1*s.*
Peru	65 % *ad valorem* and 10 %
Portugal	2*s.* $0\frac{1}{3}d.$
Rumania	$3\frac{1}{4}d.$ and $6\frac{1}{2}d.$ excise.
Sierra Leone	*ad valorem* 10 %
Spain, tea and imitations thereof and "Yerba Mate" (Paraguay tea)	$6\frac{1}{2}d.$
tea transhipped in a European port will pay an additional duty of	$\frac{1}{8}d.$
St. Helena	Free.
Straits Settlements	Free.
Sweden	3*d.*
Switzerland, in receptacles weighing less than 5 kilos	$1\frac{3}{4}d.$
,, ,, ,, over 5 kilos	$1\frac{1}{10}d.$
Tobago and Trinidad	6*d.*
Turkey	*ad valorem* 11 %
Uganda	*ad valorem* 10 %
Uruguay	$5\frac{3}{4}d.$ and 5 %
Venezuela	6*d.*

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

NOTES ON THE CULTIVATION AND PREPARATION OF TURKISH TOBACCO

The tobaccos of commerce may be roughly classified into three great groups, showing well-marked differences in their appearance and properties, brought about by different methods of cultivation and preparation. Considering only the methods by which they are prepared, these groups may be distinguished as air-cured, flue-cured, and sun-cured. The first group includes the tobaccos used for cigars, the second most of the so-called "Virginian" tobaccos used for making pipe and "Virginian" cigarette tobaccos, and the third the varieties of tobacco produced in greatest perfection in the countries of the Eastern Mediterranean, and

used in the manufacture of "Turkish," Egyptian, and similar cigarettes. Previous articles in this BULLETIN have described the cultivation and preparation of "bright Virginian" tobacco (1910, **8**, 172) and of Java cigar tobacco (1912, **10**, 248, 465), and in the present article it is proposed to give a similar account of Turkish tobacco. This tobacco is characterised by the smallness of the leaves, the yellow or orange-brown colour, and the peculiar aroma.

The best qualities of this tobacco are produced in districts near Cavalla in Macedonia and Ayasoulouk in Asia Minor. Quite recently the cultivation of Turkish tobacco has been undertaken in several other countries, and special interest attaches to the development of this industry in Cape Province of the Union of South Africa and in Rhodesia.

In Cape Province the Turkish tobacco industry was originally started under Government supervision in 1906, and may now be said to be established on a firm basis. Each year there has been a marked improvement both in quantity and quality of the leaf; complete statistics of production are not available, as a considerable quantity is sold by private treaty, but the amounts sold by public auction have increased each year, and at the last recorded sales in 1911 the quantity of Turkish leaf offered was 17,259 lb. The approximate quantity of Turkish tobacco produced under direct or indirect Government supervision in the western division of Cape Province was 40,464 lb. in season 1909–10, and 67,173 lb. in season 1910–11. The prices realised at the sales in South Africa in 1907 averaged 1*s.* 6*d.* per lb., whilst in 1911 they varied from 1*s.* to 2*s.* 7*d.* per lb., the average being 2*s.* 0½*d.* per lb., or if unbaled leaf is excluded 2*s.* 2·79*d.*

A sample of "Selouk" tobacco, grown at Simondium, Paarl Division, Cape Province, was examined at the Imperial Institute in the early part of 1910. The sample consisted of small leaves, fairly uniform in size, averaging 3 to 3½ by 1½ in., and of fine, bright Turkish type. They were in good condition and had a pleasant aroma. The tobacco held fire well, but left a rather dark ash; the aroma of the smoke was good.

The tobacco was examined with the following results:

		Per cent.
Moisture		13·09
Nicotine		1·15
Total nitrogen		2·04
Ash		7·24
The ash contained:		
Lime	CaO	16·90
Magnesia	MgO	16·08
Potash	K_2O	10·28
Sulphuric anhydride	SO_3	2·03
Chlorine	Cl.	trace

This tobacco was of satisfactory composition. The amount of potash in the ash was rather low, but owing to the small quantities of deleterious constituents present, it was sufficient to enable the tobacco to burn well.

The sample was submitted to two firms of manufacturers. One firm reported that the tobacco was well sorted and packed, but was lacking in colour for this growth. They considered it a successful attempt at copying the Turkish product, but thought the aroma needed improvement. They added that it would probably fetch a better price in South Africa than in the United Kingdom.

The second firm expressed the opinion that the tobacco would sell better if it were matured for some time, and then graded according to size and colour of leaf and re-packed. They considered that in this case the commercial value would be good, and offered to purchase one or two bales to enable them to ascertain the proportion of the different grades present. Two bales of this variety of tobacco, grown at Simondium under the supervision of the Government tobacco expert, were accordingly sent from South Africa. The firm in question reported in very favourable terms on the tobacco, stating that it was similar in quality to some grades of Smyrna tobacco, and valued it in the United Kingdom at 1*s.* 6*d.* per lb. (August 1911). These results show that with proper care and attention Turkish tobacco of superior quality can be grown in the western districts of Cape Province.

The production of cigarette-leaf from Turkish seed was first started in Rhodesia during 1904–05. The experiment was conducted under private enterprise on an area of fifty

acres. A high-grade leaf was obtained, having, even in an immature condition, a mild, sweet aroma. The growing of this class of leaf has now been gradually taken up on a larger scale, and the results are very favourable. Early in 1912, 45,933 lb. of Turkish leaf were sold at Salisbury at prices ranging from 1*s.* 1*d.* to 4*s.* 4*d.* per lb., the average price realised being 2*s.* 1½*d.* When allowance is made for crops disposed of by private treaty, it will be seen that substantial progress has been made, and the quantity of leaf produced during 1912 is anticipated to largely exceed that of the previous year.

Experiments on the cultivation of Turkish tobacco have been carried out in Ireland under the auspices of the Irish Board of Agriculture since 1900, but hitherto the cost of production has been too great to encourage farmers to take it up on a large scale. The experiments are being continued, however, in the hope that farmers, with their increasing knowledge of the requirements of the crop, will in time be able to lower the cost of production and raise the quality of the tobacco sufficiently to leave a fair margin of profit. The experiments in Ireland are of interest in showing to what extent Turkish tobacco of good quality can be produced without "sun-curing" (see p. 327).

Turkish tobacco shows in a very marked degree the peculiarity of losing its special characteristics when grown under different climatic conditions and on different soils, and for this reason it is found necessary to use new seed from Turkey at frequent intervals when undertaking the cultivation in a new country. The Turkish seed imported into Cape Province for distribution during the season 1910–11 comprised the following varieties: "Malcadji," "Baladovasi," "Dubec," "Turkish Bafra," and "Cavalla." In Ireland the most suitable varieties have proved to be "Yacca" or "Yaka" and "Giaourkoi."

Cultivation

The experience gained in Cape Province has shown that Turkish tobacco grows best on well drained soil such as grey orchard land or red soil containing 30 to 40 per cent. of clay. Black and damp soils should be avoided, as plants

grown on such soils are liable to be affected with mildew. The best situation for the fields is on the slopes of or close to mountains. The experiments carried out in Ireland indicate that a young grass field one or two years old in rotation, and first-year oat stubble, are likely to be in the best condition for the crop, owing to the presence of plenty of fibre in the soil. Old pasture land is not to be recommended, if recently turned, as the sod is not sufficiently decayed by the time the land is required for planting, and the risk of attacks of insect pests in the soil, such as wire-worms and the larvæ of "leather jackets," is serious.

In preparing land to receive the young plants, it should be ploughed three times to the depth of 8 in. and brought to a fine tilth, being finally harrowed, or better still rolled. Virgin soils must be ploughed and allowed to lie fallow at least one year. The manuring is done preferably with sheep or goat manure, which should be applied at the rate of 6 tons to the acre, or the animals may be fed on the land when it is not occupied by tobacco. If too much manure be added the growth is rank and succulent and the quality of the tobacco consequently poor. Experiments are at present in progress in Cape Province to determine whether artificial manures are as suitable as natural manures. In Rhodesia good results are said to have been obtained by their use, whilst in Cape Province a yield of 700 lb. per acre was obtained by the use of artificial manures, the best tobacco being produced on a ¼-acre plot which had been manured with 72 lb. superphosphate, 40 lb. sulphate of potash, and 40 lb. nitrate of soda.

Seed Beds.—A warm, sheltered spot should be selected for the preparation of the seed beds, which should be 3 ft. in width and separated by narrow paths. The soil is first removed to a depth of 10 in., and 4 in. of hot manure laid at the bottom, the remaining space being filled in with a mixture consisting of one-third soil and two-thirds of old rotted manure. The surface is worked to a fine tilth and the bed watered before sowing the seed, which must be done uniformly at the rate of two to three ounces to 100 square yards of seed bed; the seed is covered with about one

quarter of an inch of sand, either alone or mixed with sifted, well-decayed manure. In order to allow for loss incurred by late frosts or otherwise, it is advisable to sow a succession of seed beds at intervals of about a week or ten days during November and December in South Africa, and at the end of March and the beginning of April in Ireland. It is a good plan to sterilise the soil of the seed beds, either by making a fire with branches or rubbish on the bed until the soil is scorched to a depth of 3 in., or by means of steam, in order to destroy insect pests, weeds, etc. The young plants must be protected from frost, wind, and insect pests, and this is best done by covering the beds with muslin or butter cloth supported on sticks about 6 in. above the soil and closed in on all sides. In a climate such as that of Ireland the protection afforded by muslin is insufficient and the seedlings must be raised under a frame on a hot-bed of horse-manure. The seed bed in such cases should consist of rich, friable soil, placed to a depth of about 4 in. on the manure. A convenient size for the sashes is 6 ft. by 4 ft., and about 20 or 30 would be necessary for each acre of land. The temperature in the frame should be kept at about 60° to 80° F. and should never exceed 100° F., whilst careful ventilation and watering are necessary, during the early stages of growth, to prevent "damping off." The seed must be sown thinly, at the rate of $\frac{1}{64}$ to $\frac{1}{32}$ oz. per sash.

The beds are kept moist, and when the seeds germinate, which takes place in from ten to fifteen days, watering is continued daily. When the plants are about half an inch above ground a little guano water may be applied at least once a week. Before the plants are transplanted, it is necessary to harden them by removing the covering from the beds about a fortnight before the planting, and also to discontinue the watering for the last week, except on the evening previous to taking up the plants.

Transplanting, etc.—When the plants are about 5 in. in height they are taken from the seed beds and planted in the field already prepared for them. Care must be taken to prevent the roots becoming dry, and if possible the work should be conducted on a cloudy day, or late in the after-

noon. The distance apart at which the plants are set varies in different countries. Mr. Stella (*Cape of Good Hope Agric. Journ.*, 1909, **34**, 377) recommends placing the plants 8 or 9 in. apart, and having a space of 3 ft. between the rows. Mr. G. M. Odlum (*Rhodesian Agric. Journ.*, 1906–7, **4**, 25) considers that in Rhodesia the seedlings should be planted 6 in. apart, with an 18 in. space between the rows. According to Christy's *New Commercial Plants*, No. 1, the spacing of the plants in Turkey is even more limited, for they are planted not more than 5 in. apart, the space between the rows not exceeding 9 in. In Ireland a distance of 9 in. between the plants and 30 in. between the rows is recommended for the "Samos," and 7 in. and 24 in. respectively for the "Yacca" variety (*Journ. Bd. Agric., Ireland*, 1910, **10**, 473). The spacing of the plants depends in some measure on the climate and soil, and can only be determined in a new country by experiment. In this connection it is necessary to bear in mind that close planting is essential with Turkish tobacco, to produce plants with small leaves. The number of plants required per acre will naturally depend on the spacing, but 50,000 to 60,000 will usually be found sufficient. A fortnight after planting, hoeing is necessary, and from this time until the operation of priming, hoeing must be done frequently in order to keep down weeds and maintain a surface mulch.

The removal of the terminal bud of the plants, a practice known as "topping," must not be carried out with Turkish varieties, and for this reason very little trouble will be caused by suckers, but should these form they must be nipped out when between 1 and 2 in. long.

Priming.—When the plant commences to bloom and the lower leaves to turn yellow, four to six of these should be picked and destroyed. In Turkey eight or ten of the lower leaves are thus destroyed in the priming. In Ireland priming is unnecessary, as the lower leaves suffer comparatively slight injury or deterioration. About ten days or a fortnight after priming, the crop leaves proper commence to ripen, and this stage is indicated by the following changes:

(1) The lowest and the oldest leaves show a yellowish

tinge in place of the previous vivid green, and this is most obvious at the tips.

(2) The leaves feel soft and limp instead of crisp.

(3) The ripe leaves are more translucent when held up to the light.

With Cavalla and other varieties, grown on rich soil, yellow spots appear on the leaves, and when these are distinct the leaf is ripe.

Preparation of the Tobacco

Gathering and Threading the Leaves.—The ripe leaves are gathered in the early morning, whilst still damp with the dew, but after rain only when all signs of moisture have disappeared, as otherwise the leaves are apt to turn mouldy. In picking the leaves it is better to err on the side of over-ripeness than risk taking green leaves, as the latter retain a greenish tinge after curing; over-ripe leaves lose colour and strength in curing. As a rule one or more ripe leaves are plucked from each plant, but in no case more than four at one picking. Immediately after the leaf is broken off the ruptured base should be squeezed hard between the thumb and finger. This is said to be of importance in preventing loss of sap and facilitating the development of the slight stickiness which is characteristic of good Turkish tobacco. The picked leaves are placed evenly one above the other and all facing the same way, in baskets, and taken to a cool shed, where they are sorted according to size, and threaded on pieces of strong twine about 8 ft. long, so that the leaves all face one way, and are packed close together. The string of leaves is attached lengthwise to a rod and then taken to the curing shed.

Curing.—In the operation of curing there are three distinct steps: first, the rods holding the threaded leaves are placed side by side about 6 in. apart in the curing shed, and supported at the ends on wooden rails. The object is to allow the leaves to wither slowly and turn a pale yellow colour, a change which usually occupies three or four days. The curing-house may consist of any convenient outhouse, clean and cool, and if possible with a temperature not higher than 70° F.; it should be of such construction that

the contents are not exposed to heat, wind, dust, rain, or light.

In the second stage of the curing, the withered leaves are exposed to the sun in the open, preferably in a spot sheltered from the wind. For this purpose the rods holding the leaves are placed side by side on two parallel wires fixed about 2 ft. from the ground. On the first day the rods are placed as close as possible without letting the leaves touch, and should the sun be very hot the leaves must be protected by a canvas covering. On the second day the distance between the rods is increased to 4 in., and on the third and subsequent days a space of 6 in. is allowed. The object is to avoid sudden and too rapid drying and to attain a good colour, for there is at this stage a gradual change from a pale yellow to a warm yellow-brown colour. This process usually requires from twelve to fifteen days, depending on the weather. Provision must be made for quickly placing the leaves under cover should rain threaten, and in the event of continuous rainy weather it will be necessary to provide artificial heat in the shed in order to reduce the dampness of the atmosphere and prevent attack by moulds. While the leaves are in the open they must be covered every night. When the midrib of the leaf is brittle and apparently dry the rods carrying the leaves are laid on the grass, or failing this, on clean sacking, and allowed to remain for the whole of one day, protection during the night being supplied as before. On the following day the rods are turned over to expose the other surface of the leaves to the sun; this treatment is repeated on the two succeeding days, and the leaves are then removed to the shed and stacked until it is convenient to bale them.

It is the usual practice to sun-cure Turkish tobacco, but experiments conducted in Rhodesia and elsewhere indicate that these tobaccos can also be flue-cured (*Rhodesian Agric. Journ.*, 1906–7, **4**, 357, and this BULLETIN, p. 26). By this method it is contended that losses due to unseasonable weather are avoided, the colour is brighter and more uniform, and there is no apparent loss in flavour or aroma. The Turkish leaves change much more rapidly than

Virginian leaf in the flue-barn, and consequently all the stages are of shorter duration, and the highest temperature used should not exceed 120° to 130° F. The steam-barn has proved suitable for curing Irish-grown tobacco, its chief advantages being that both temperature and humidity are more easily controlled than in a stove-heated barn. As soon as the barn is filled the temperature is raised rapidly to 80° F., and the ventilation regulated so that a wet-bulb thermometer shows about 2° depression. These conditions are maintained for about 24 hours, after which the atmosphere may be gradually made drier, so that the depression of the wet-bulb thermometer is increased to 4° or even 10° by the end of the yellowing period. When the green colour has given place almost completely to yellow the temperature should be raised rapidly to 130° F., and the ventilation increased to secure a depression of 30° or more. This is necessary to prevent the leaf turning brown before the yellow colour can be fixed. The fixing of the colour may require 8 to 12 hours, after which a continuation of this temperature will "kill" the leaves completely in 12 to 18 hours.

Baling.—The leaves have next to be pressed into bales, and this operation is best undertaken in damp weather when the leaves are supple. If the tobacco is too dry and therefore brittle, it is sprayed very lightly with water on one side of the leaves only, and restacked and covered for two days. In carrying out this operation great care is necessary, for if the leaves are made too damp they will become mouldy in the bale.

Another method of rendering the leaves fit for baling is to subject them, while still on the rods, to the action of steam for a few seconds in a specially constructed steam chest. This is done immediately before baling, as the leaves only retain their suppleness while warm; by this means the conditioning of the leaves is facilitated, and there is less risk of making the tobacco too damp. In baling the tobacco a box-press is used with a screw-down lid, which loosely fits the inside of the box. The strings of leaves are cut from the supporting rods, and divided into lengths corresponding to the size of the bale;

the tobacco is packed into the box in layers, the "butts" of the leaves being turned outwards, and the "tips" towards the centre. The box is gradually filled under pressure, and when full the pressure is continued for three or four hours. The bale is then removed and sown up in canvas with the ends left open and laced together in a criss-cross manner. Each bale weighs about 80 lb. By storing the tobacco in this condition it matures and improves with age.

GENERAL NOTES

A Tropical Agricultural College.—The following letter on this subject, from Prof. Dunstan, was published in the *Times* of April 29 last:

"Sir,—As I have spent over fifteen years in a detailed study of tropical agriculture in all its aspects, and two years ago advocated the establishment of a college of tropical agriculture, perhaps you will allow me to offer some remarks on this subject, to the importance of which you have opportunely directed attention.

"In the discussion on Mr. John Ferguson's paper on 'Planting in Ceylon, Malaya, and Java,' which was read at the Royal Colonial Institute in 1911, and again in the introduction I contributed in the same year to Mr. Hamel Smith's 'Notes on Soil and Plant Sanitation on Cocoa and Rubber Estates,' I alluded to the need for a system of training for those who wish to enter the profession of 'planting' or tropical agriculture. This profession is one of the few in which no technical education has been provided, and for which an ill-defined system of apprenticeship known as 'creeping' is still regarded as sufficient. Yet tropical agriculture and its results are of far-reaching importance to the Empire. The matter is one which demands the serious consideration of the Government of this country, as well as those of our tropical colonies.

"Young men in increasing numbers are proceeding from this country to the tropics to engage in agriculture, usually with no preliminary technical education whatever. Important posts in Government Departments of Agriculture in our tropical colonies are difficult to fill owing to the want of efficiently trained and experienced men. Owing to the absence of such men to fill administrative posts in tropical agriculture, directorships of agricultural departments are given in some instances to soldiers and in others to civilians with no technical qualifications.

"What I have advocated is the establishment of a

college in the tropics, where young men who have already laid the foundations of their general training in this country at an agricultural college can proceed for one or two years in order to study the special problems of tropical agriculture on the spot. This is not the place to discuss the subject in detail.

"As you have remarked, the question of the site for such a tropical college (the term 'university' is hardly appropriate in this connection) is of secondary importance, and more than one college will no doubt be required. It is, however, necessary that there should be one large and well-equipped institution in the tropics, suited to the needs of most of those who will engage in tropical agriculture.

"Having regard to the requirements of the majority of the men to be trained, I am in favour of Ceylon as being on the whole the country best suited for the establishment of this college. Besides possessing more than one variety of climate, two of the most important products of tropical agriculture can well be studied there—namely, rubber and tea, whilst other tropical crops, such as coconuts, cocoa, spices, and foodstuffs, are also well represented. Ceylon, moreover, contains a large, influential, and enterprising planting community, both European and native, and also now possesses an agricultural department whose co-operation in the establishment of a College of Tropical Agriculture would be of great advantage.

"The proposal to establish such a college in Ceylon appears to have been very favourably received by all classes in the Colony.

"It has to be remembered that the call for trained agriculturists is chiefly from the East (India, Ceylon, and Malaya), and that a considerable proportion of the men to be trained will expect to gain through their study in the tropics the latest experience in the production of Para rubber and tea.

"For these reasons alone the West Indies are less suitable as a training-ground, especially for those who are afterwards to proceed to the East. No one, however, would wish to interfere with the desire of the West Indies to start a College of Tropical Agriculture, and this is a subject in which not only the Imperial Department of Agriculture for the West Indies is interested, but also the independent and efficient Departments of Agriculture in Jamaica, Trinidad, British Guiana, and Barbados. In Trinidad proposals are already under discussion for the establishment of such a college. It is clear, however, that a Tropical Agricultural College in the West Indies must chiefly serve local needs, as indeed Mr. Norman Lamont has already indicated in his interesting articles on the subject.

"A course of training at an agricultural college in this country, followed by one in Ceylon, ought to qualify a man to carry on tropical agriculture in any part of the world. Local conditions, practice, and crops vary in tropical agriculture as they do in temperate agriculture, but a properly trained man will find no difficulty in mastering the special problems of a new country.

"Next year an International Congress of Tropical Agriculture is to be held in London, and discussion of the steps to be taken to provide technical education in tropical agriculture is one which will doubtless claim a foremost place in its programme.

"Unfortunately there is still a good deal of ignorance, even in high places, as to the status of tropical agriculture. It is still often regarded as little or nothing beyond the art of horticulture or gardening, or as a subject on which any botanist can claim to be an authority. It is now recognised in this country that temperate agriculture is an applied science, and numerous colleges exist in which this subject and the related special sciences of botany, chemistry, entomology, etc., are efficiently taught, whilst the Government is wisely endowing agricultural research on an extended scale. Tropical agriculture is on the same footing, and merits at least equal consideration, especially in view of our commercial dependence on an adequate supply of many tropical products, and of the need of developing the resources of the tropical countries of the Empire.

"I am grateful to Colonel Arnold for his recognition of the services which are now being rendered by the Imperial Institute to the cause of agricultural production in the British tropics. As, however, he justly remarks, no institution in this country can alone do all that is needed, unless efficient provision is made in tropical countries for technical education and research.

"Mr. Sampson's letter raises a somewhat different point. The study of indigenous or native agriculture must certainly not be neglected, but there is no real distinction in kind between the principles of 'native' and 'capitalist' agriculture. In several British countries in which efficient agricultural departments exist, such as West Africa and Uganda, the principal object is to study and improve the native systems of agricultural procedure

"The instruction of natives in tropical agriculture is an important subject, which has already received attention in India, Egypt, and elsewhere, but it is one which requires separate treatment.

"I am, etc., WYNDHAM R. DUNSTAN."

The Volatile Oil of Alpinia alba Fruits.—A small quantity of the fruits of *Alpinia alba*, Rosc. (*Amomum medium*,

Lour.) was received at the Imperial Institute from Hong Kong in 1911. The fruits, on examination, were found to contain a volatile oil, which occurred almost entirely in the seeds. The oil has been examined by Dr. S. S. Pickles and Mr. J. C. Earl, of the Scientific and Technical Department, Imperial Institute, and a paper on their results has been contributed to the Chemical Society of London (*Proc. Chem. Soc.* 1913, **29**, 164).

By distilling the fruits with steam, about 1 per cent. of a pale yellow oil, having an odour recalling those of lemon and eucalyptus, was obtained. The following constants were found for the oil: D $15°/15°$ 0·9366, α_D (in a 100 mm. tube at 20° C.) – 2° 15′.

The oil, of which only 70 cc. were available, was shaken, first with dilute sodium carbonate, next with sodium bisulphite solution, then with dilute sodium hydroxide, and finally with 50 per cent. resorcinol solution, to absorb cineole.

From the results of this treatment and the subsequent examination of the various products, the composition of the oil was found to be approximately as follows: Cineole, 69 per cent., characterised by the crystalline addition product with iodol; aldehydes and ketones, 27·5 per cent., consisting mainly of citral, which was characterised by means of the semicarbazones and the β-naphthacinchoninic acid; phenols, 1·5 per cent.; acids, 1 per cent. A small quantity of a crystalline acid, m.p. 46°–48° C., was isolated, but not in sufficient quantity for identification. The residue, amounting to about 1 per cent., seemed from its odour to consist chiefly of terpenes.

A new variety of "Manna" from Rhodesia.—A specimen of leaves and twigs, partly covered with a white incrustation ("manna"), was received recently at the Imperial Institute from North-western Rhodesia. The plant was submitted to the Royal Botanic Gardens, Kew, where it was identified as a species of Gymnosporia, probably *G. deflexa*, Sprague. The results of examination of the "manna" at the Imperial Institute have been communicated, by Dr. J. R. Furlong and Mr. L. E. Campbell, to the Chemical Society of London (*Proc. Chem. Soc.* 1913, **29**, 128).

The incrustation had a slightly sweet taste. It was for the most part evenly deposited, and could be easily separated from the leaves and twigs. It was found to contain 4·9 per cent. of moisture, and on dissolving in hot water and adding alcohol to the filtered solution, a crystalline substance separated in highly lustrous prisms melting at 183° (uncorr.) and 188° (corr.). This substance, which was isolated to the extent of 54 per cent. of the weight of manna used, was proved to be dulcitol.

The residue of the manna, after the removal of the dulcitol, was a pale brown, sweet, gummy material, which

reduced Fehling's solution and gave indications of the presence of a furfuraldehyde-yielding complex. It contained 6·4 per cent. of reducing sugar, calculated as dextrose, and after heating with dilute acids yielded reducing sugar equivalent to 6·6 per cent. of sucrose, these two figures being expressed on the original manna. The residue could not be further examined owing to the small quantity available.

Scarlet-runner Roots.—The statement has been made frequently (cf. *Treasury of Botany*, Ed. 1899, Part II. p. 874; *The Vegetable Kingdom*, by Lindley, 3rd Ed., 1853, p. 548; and Thompson's *The Gardener's Assistant*, 1901 Ed., vol. II. p. 512) that the roots of the common scarlet-runner beans (*Phaseolus multiflorus*, Lam.) are poisonous. This is of considerable interest in connection with the work that has been done at the Imperial Institute on the closely related plant, *P. lunatus*, one result of which was to show that the seeds of wild forms of this plant are poisonous, whilst those of the cultivated forms are not. It was proved that the seeds of wild *P. lunatus*, when ground and mixed with water, yielded prussic acid in poisonous quantities, whilst from the large white beans obtainable from the highly cultivated forms of the plant no trace of this acid could be obtained. This work has been described in detail already in this BULLETIN (1903, **1**, 15, 112; 1905, **3**, 373; 1906, **4**, 334; 1912, **10**, 653).

The roots of the scarlet-runner bean grown at Dartford in Kent have been examined recently by Drs. Power and Salway, of the Wellcome Chemical Research Laboratories, and shown to contain no poisonous constituents. A number of well-defined substances have been obtained in the pure state from the roots and identified or characterised by these authors (*Pharm. Journ.* 1913 [iv.], **36**, 550), but none of these is poisonous. Special search was made for cyanogenetic compounds, but with negative results. It may be mentioned that a number of samples of scarlet-runner roots, stems, leaves, and beans were examined at the Imperial Institute some years ago for cyanogenetic compounds, and in no case was any evidence of the presence of such substances found. The scarlet-runner material examined by Drs. Power and Salway and at the Imperial Institute, however, was all derived from cultivated races of the plant, grown in the United Kingdom, and it remains to be seen whether, as in the case of *P. lunatus*, there may be wild or semi-cultivated forms of the plant which yield poisonous constituents. In this connection it is interesting to note that the fact first recorded by Cordemoy that the toxicity of *P. lunatus* beans disappears on cultivation, and which was first explained by the work done at the Imperial Institute ten years ago, has now been shown to be true for white clover

(*Trifolium repens*) by Prof. H. E. Armstrong, Dr. E. F. Armstrong, and Mr. E. Horton (*Proc. Roy. Soc.*, Ser. B, 1913, **86**, 267).

Sisal Hemp Industry of Fiji.—The cultivation of Sisal hemp has been carried on at the Experiment Stations of the Department of Agriculture in Fiji since 1907. Satisfactory results have been obtained at both the Nasinu and Lautoka Stations, situated respectively in the wet and the dry regions of the Island of Vitilevu; but the dry zone is specially recommended for Sisal cultivation. A sample of fibre obtained from plants grown in the grounds of Government House, Suva, was examined some years ago at the Imperial Institute (this BULLETIN, 1908, **6**, 387), and, although the locality was not the best suited to the growth of the plant, the fibre was of excellent quality, and was valued at £34 to £35 per ton, with Mexican Sisal at £25 to £27 per ton. In order to encourage planters to take up the cultivation of Sisal the Government offered a bonus of £500 on the first 10 tons of fibre exported from the colony. According to information supplied to the Imperial Institute by the Colonial Office, this bonus has now been paid to the Vesari Sisal Hemp Company.

Plants Protection Ordinance in Nyasaland.—The danger to planting industries in the colonies and dependencies of the introduction of insect and vegetable pests is a very serious one, since it is almost impossible to eradicate such pests when once they have obtained a footing in a locality, and they may render all the efforts of the planter valueless; it is therefore of the greatest importance that regulations should be made and enforced to prevent such a catastrophe. In the Nyasaland Protectorate ordinances have been published in the *Government Gazette* of November 30, 1912, and of January 31, 1913, prohibiting the importation of cotton plants and seeds, with the exception of those grown in Egypt and of those imported for experimental purposes by the Director of Agriculture, and packed in double bags or tins. In the case of these and of other "plants," which term includes growing trees and portions of plants, such as cuttings, buds, grafts, bulbs, roots, seeds, fruits, and vegetables, every package imported through the post must contain a statement of the kind and variety of plant, the country of origin, and the name and address of the sender, and, when necessary, a certificate. In the case of rubber, cocoa, coconuts, rice, tobacco, and potatoes, a certificate must be obtained from the Official Agricultural Authority of the country of origin to the effect that the plants have been grown in areas known to be free from diseases or pests which characteristically attack such plants. In the case of tea and coffee, permission to import must be obtained previously from the Director of Agriculture in

Nyasaland. The package will be inspected by the Agricultural Department, and, if necessary, disinfected.

When it is intended to import plants otherwise than through the post, similar documents are to be posted by the consignor to the Comptroller of Customs, so as to reach him one month in advance of the consignment. Plants for which the documents have not been received will be detained; and if, one month from the time of their arrival, the documents have not been received, they will be liable to be confiscated, or to be dealt with as the Agricultural Authority determines. Plants accompanying a person entering the Protectorate must be declared to the Customs Officer, and similar information and certificates must be given. All plants are to be securely packed, and will be disinfected, if it is considered necessary by the Agricultural Authority.

All plants and packages are to be landed at Port Herald, or at a place substituted for it by proclamation in the *Gazette*, except when special permission has been obtained from the Governor. If special permission has been obtained, or if the importation exceeds 20 cubic feet in bulk, or half a ton in weight, the importer is to pay the expenses of disinfection. If the pest or disease on any plant cannot be destroyed by disinfection, the plant is to be destroyed. The Director of Agriculture may require any imported plant to be grown apart from other similar plants if he thinks it advisable.

Native Produce in the Sokode-Bassari District of Togoland.—Reports on the native produce of all the districts of the Togoland Protectorate are being prepared by order of the Government, and are in course of publication; that for the Sokode-Bassari district is given in the *Mitteilungen aus den Deutschen Schützgebieten* (1912, **25**, 239). This district lies 200 miles from the coast, and has a population of about 300,000, belonging to several different races; now that internecine wars have ceased under German rule, it is possible for the natives to devote their attention to agriculture, and some of them are excellent farmers. There is only one rainy season in the year—it lasts from April to October; the rainiest months are August and September, and the average annual fall is 51 in. As regards tenure, land that has not yet been used can be taken by any inhabitant or stranger; cultivated land belongs to the cultivator even when left fallow for several years; but the possession is not definite, and any one can cultivate a field left fallow, though as a matter of courtesy he is expected to ask permission of the former owner. In most sections of the district there is ample land for the population, but in Transkara there is scarcely 5 acres per head.

The report goes very fully into the native crops,

describing the way they are grown and used, and their different varieties, with their merits and defects; it also deals with the wild produce, and with the live stock of the farms, and gives the native names in the numerous languages. Yams and sorghum form the staple foods; the latter is also used for making beer. Sweet potatoes, maize, okro (*Hibiscus esculentus*), ground nuts (*Arachis hypogæa*), *Voandzeia subterranea*, *Kerstingiella geocarpa*, *Vigna sinensis*, cassava, taro, sesame, gourds, and melons are widely grown; and the varieties of gourds afford calabashes of various shapes and sizes. In addition to these there are *Helmia* yams, a species of *Coleus* which is an efficient substitute for potatoes, rice, *Pennisetum americanum*, *Digitaria longifolia* subsp. *esculenta* a grass with edible seeds, *Phaseolus lunatus*, *Cajanus indicus*, and *Sphenostylis stenocarpa*. Auxiliary foods are pepper, onions, tomatoes, ginger, tiger-nuts (*Cyperus esculentus*), papaws, and bananas. The mango tree has been introduced and is appreciated.

Among wild or partially-cultivated plants, the oil palm (*Elæis guineensis*) is of great importance. The number in the district has been estimated at half a million. The products, palm oil, kernels, and soap, are at present so much in demand and so highly valued that there is no prospect of an oversea trade; but it must not be considered impossible that the natives might in the future plant oil palms to sell the fruit to agencies. The shea tree (*Butyrospermum Parkii*) occurs throughout the district, though the natives do not plant it; shea butter is prepared from the nuts by the women, and is much esteemed as an article of commerce, finding a market in the southern districts and in the Gold Coast, and some is exported to Europe; and there seem possibilities of increasing the export. The introduction of simple machinery for extracting the fat is suggested.

The fibre plants are cotton, kapok (*Eriodendron anfractuosum*), *Bombax buonopozense*, *Calotropis procera*, *Polygala butyracea*, *Hibiscus cannabinus*, *Urena lobata*, one variety of *Vigna sinensis*, and the borassus palm. Other plants with useful properties are tobacco, *Strophanthus hispidus*, used for making arrow poison, the castor-oil plant, and *Tephrosia Vogelii*, the leaves of which, powdered and thrown into the water, have the effect of poisoning the fish and making them float on the surface, where they can be captured.

Rubber is obtained from *Landolphia owariensis*, and efforts are being made to introduce *Manihot Glaziovii*.

The report closes with much valuable information about the products, their botanical and native names, times of planting and harvesting, utilisation, yields per hectare, market prices, and freight to Germany put into tabular form.

Geology in Egypt.—The progress of geological work in Egypt during recent years is indicated by the issue, during 1912, of two important publications by the Survey Department. One of these is a useful volume entitled *Explanatory Notes to Accompany the Geological Map of Egypt*, by Dr. W. F. Hume, the Director of the Geological Survey. The geological map referred to was published during 1911 on two scales: (1) Scale 1 : 1,000,000 in six sheets; (2) Scale 1 : 2,000,000, reduced from the above, in one sheet. The map is based on the explorations carried out by the Geological Survey since 1897.

The explanatory notes give a brief and lucid account of the nature and distribution of the stratified rocks, their palæontology, and the history of geological changes in the country. The latter and larger part of the volume is occupied by two tables in which a great deal of information has been condensed. One of these is a table of the geological formations, with notes on the characteristics of the formations in different parts of the country, and full bibliographical references. The second table deals with the distribution of economic mineral products in Egypt. The volume includes two coloured sections, one a horizontal section across Egypt from Kharga Oasis to near Gebel Gharib and the Gulf of Suez; the other a vertical section showing the succession of the sedimentary strata. The map and notes will prove very useful to all who are interested in a general way in the scientific and economic geology of Egypt.

The second publication gives a detailed account of *The Geography and Geology of South-eastern Egypt*, by Dr. J. Ball. The section dealing with the geography of the region includes an account of the surveying methods employed and the principal geographical results obtained. It is noteworthy that some of the surveying methods used are either new or little known, and are such as have been found to be specially adapted to the mapping of the type of country met with in this part of Egypt. Drainage features and water supplies are dealt with. A fairly full account is given of the petrology of the region; and there is a chapter summarising the general geological structure and history of this part of Egypt. The book is elaborately and very well illustrated, and the illustrations include twenty-eight plates.

Both the above publications are incidentally of special interest as giving the views now entertained by the officers of the Geological Survey concerning certain important structural features in Egypt. The view has prevailed among geologists for many years that the Red Sea owed its origin to trough-faulting, and that it was an example of the "Rift-valley" type of structure which has been so freely assumed to exist in many parts of Eastern Africa.

It is therefore of considerable interest to note Dr. Ball's statement (p. 355) that "the inference from the contours is that the present extent of the Red Sea has been caused by a great general subsidence of the land, and not by trough-faulting, as has hitherto been stated."

Equally significant is Dr. Hume's remark in his explanatory notes (p. 3) that "the fractures which have been observed in or near the Nile Valley do not afford convincing proof that its deep-cut ravine results from fault-effects, erosion following local folding being perhaps sufficient to account for all the conditions observed."

Mineral Production of Ontario.—The *Twenty-first Report of the Ontario Bureau of Mines*, 1912, gives the total mineral production of Ontario during 1911 a value of $41,976,797, an increase of 6·7 per cent. on that for 1910. Of this value, 70 per cent. was represented by metallic minerals and 30 per cent. by non-metallic minerals. During the six years ending with 1911, the annual production has increased by 87 per cent.

The silver output was 31,507,880 oz., valued at $15,953,895, an increase in quantity of 856,463 oz., and in value of $472,573, as compared with 1910. Practically the whole of this silver was obtained from the mines of the Cobalt district. The amount of ore shipped continues to decrease, and there is a corresponding increase in the proportion of concentrates and refined bullion. The concentrating plants at the end of 1911 had a total capacity of about 1,730 tons of ore per day; and during the year, 9,443 tons of concentrates were produced from 387,782 tons of ore. It is estimated that the ore sent to the mills contained on the average about 25·4 oz. of silver per ton.

The mines of the Sudbury district yielded 612,511 tons of nickel-copper ore during 1911. Of this amount, 610,788 tons were smelted, yielding 32,607 tons of Bessemer matte which contained 17,049 tons of nickel, valued at $3,664,474. This represents a decrease in production of nickel of 1,587 tons in 1911 as compared with 1910, though at the end of the year the mines were producing at full capacity.

The copper production was valued at $1,281,118, a decrease of $92,985 as compared with 1910. Practically the whole of the copper was obtained from the nickel-copper mines of the Sudbury district.

The output of iron ore amounted to 175,631 tons, valued at $445,930, a decrease in value of $67,791 as compared with 1910. A further substantial increase in the iron-smelting industry of the province took place during the year, and no less than 848,814 tons of iron ore was imported. The total iron ore smelted amounted to 916,445 tons, of which only about 7 per cent. was obtained in Ontario, the remainder coming chiefly from the United States. The total

value of the pig-iron produced was $7,716,314, an increase of $740,896 on the production for 1910.

The production of petroleum continues to decline, the value for 1911 being $353,573, a decrease of $14,580 on the output for 1910. The production of natural gas, on the other hand, is rising rapidly, the output for 1911 being valued at $2,186,762, an increase of $695,523 on that for 1910.

There were also increases in the production of salt, iron pyrites, arsenic, felspar, talc, gypsum, fluorite, and cobalt; and decreases in the output of gold, limestone, corundum, quartz, mica, and graphite.

Mineral Production of Western Australia.—According to the *Report of the Department of Mines for the year* 1911, the total mineral production of Western Australia for that year had a value of £6,105,853, a decrease of £416,410 on that for 1910. Of this total, gold contributed £5,823,075, or 95·36 per cent.

The gold output continues to decrease, the output for 1911 being 99,764 oz. less than that for 1910, while the output for 1910 was 124,637 oz. less than that for 1909. For the State as a whole, the ore-value per ton in 1903 was 77·1*s*., with a profit of 18·7*s*. per ton; in 1910 the value had dropped to 41·48*s*., with a profit of 7·1*s*. per ton; and in 1911 to 41·19*s*., with a profit of 6*s*. per ton. The East Coolgardie gold field produces over 50 per cent. of the State's output of gold, and in this field the average value per ton of ore treated fell from 40·32*s*. in 1910 to 38·14*s*. in 1911. The decrease in gold production is due in large part to a falling off in the East Murchison field, where several mines have been closed; but all the fields have suffered decreases in output, with the exception of Ashburton. Various causes are mentioned to explain the decrease in the State's gold production. Of these, perhaps the most significant is the diminution in value of the ore as greater depths are reached in the mines.

The value of the tin ore output was £60,702, and the exports show an increase of £10,091 compared with 1910. Of this, the Greenbushes tin field contributed about 75 per cent., the rest being obtained from the Pilbara tin field.

Six coal mines on the Collie coal field produced 249,890 tons, valued at £111,154, a decrease of 12,276 tons in quantity and £2,545 in value on the output for the previous year. This decrease was chiefly due to the outbreak of fire on one of the mines. A new coal mine was opened during the year, and the district is flourishing.

The copper output was valued at £78,118, a decrease of £17,810 on that for 1910. Among the less important minerals, there were increases in the output of lead ore, pyritic ore, tungsten ore, and zinc ore, and a decrease in

silver. No tantalite was reported or exported, consequent on the absence of any market.

The Government continues to assist prospectors with equipment and means of transport, and also gives assistance in the development of partly opened-up mines.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

SOILS AND MANURES

Soils.—The chemical and mechanical composition of seven soils from the Federated Malay States are given in *Agric. Bulletin F.M.S.* (1913, **1**, 210). The soils are all of a heavy-clay type, and are deficient in calcium carbonate, but contain adequate percentages of potash. The quantity of phosphoric acid shows great variation, often being much below 0·05 per cent.; the humus varies from 2·0 to 4·5 per cent.

Peaty swamp-lands and their agricultural treatment are discussed in *Bulletin* 157, 1912, *Univ. Illinois Agric. Exp. Stat.* The soils vary from those consisting almost entirely of peat to the so-called "muck" soils, which have a fair proportion of true soil in them. Those examined were often found to be surrounded by sandy soil, which in many cases also formed the subsoil. The peaty soils of this region appear to be characterised by a high content of nitrogen and phosphoric acid, and by a marked deficiency in potash. Plot experiments, conducted at several farms with manures containing potash, phosphate, lime, and nitrogen, confirmed these deductions. The application in the first year of 200 lb. of potassium sulphate per acre, and 100 to 200 lb. in succeeding years, produced yields of maize varying from 41 to 55 bushels per acre from land which yielded none formerly. Manures containing lime, phosphoric acid, or nitrogen proved useless in many cases without simultaneous application of potash. Farmyard manure proved effective, but is usually more economically kept for use on soils where its organic matter will be of service.

The reclamation and use of the marsh- and swamp-lands of the eastern part of the United States is considered in *Circ.* 69, 1912, *Bur. Soils U.S. Dept. Agr.* Reclaimed marsh and swamp soils have proved suitable for the

cultivation of maize, cotton, and hay, whilst yields of 40 to 60 bushels of rice per acre have been obtained from reclaimed tidal marsh.

Green Manures.—An account of recent experiments on green-manuring in Dominica is given in *Rep. Agr. Dept. Dominica*, 1911–12, p. 6. Numerous attempts to grow soy beans for this purpose have proved unsatisfactory, as the plants only attained a height of about 6 in. before seeding. One of the most promising plants tried was *Tephrosia candida*, which, in a light, open soil, attained a height of 6 ft. before flowers appeared, and is recommended for use in rubber plantations, as it keeps down weeds. *T. purpurea* was found to be less suitable. The Jerusalem pea (*Phaseolutus trinervis*) was found to do well as a cover crop where its twining habit is not likely to prove detrimental to the chief crop. Fungoid disease and insect pests rendered the experiments with chick pea (*Cicer arietinum*) inconclusive.

The utility of the Sesbanias as green manures for use in India is discussed in *Planters' Chronicle* (1912, **7**, 484, 593). *S. aculeata* has been employed successfully for manuring tea, rice, and tobacco in Bengal, and *S. cannabina* ("dhaincha") is used on Assam tea estates. *S. ægyptiaca* is said to be suitable for manuring rubber plantations.

Bulletin No. 1, 1912, *Agric. Dept., Bengal*, describes results of green-manuring experiments carried on at the experimental farms in Eastern Bengal and Assam. "Dhaincha" has been found to grow well on all kinds of soil, even when part of the plant is for a time submerged in water, and to be more resistant to insect pests than Sunn hemp. Attention is directed to the desirability of retaining in the Province products, such as bones and cotton seed, which have a high manurial value and are at present exported in large quantities.

Oils and Oil Seeds

Coconuts.—The coconut tree is widely distributed in India, and coconut products are important articles of internal trade (*Ind. Trade Journ.* 1913, **28**, 254), while fair amounts of copra and coconut oil are exported. In spite of the atmospheric humidity of the littoral tracts and the short dry season, Malabar copra fetches high prices. Artificial drying should tend to the production of better copra, and would allow the makers of copra to extend their season and so avoid the drying of immature nuts. Efforts are being made to prepare substitutes for "ghi" from coconut oil.

According to Moors (*Tropical Life*, 1913, **9**, 34), the area under coconuts in Samoa has been largely increased by enforcing, since 1904, an ordinance that every able-bodied native should plant at least fifty nuts yearly, spaced 30 ft. apart and keep the area so planted free from weeds. The

author considers that the usual statement that coconut trees commence to bear fruit in their fifth or sixth year is incorrect, at any rate for Samoa: small fruits do appear in the fifth year on trees in very favourable positions, but these do not develop, and only a small crop is obtained in the sixth year. It is often stated that the trees bear 100 nuts per year, but the author believes that this is also incorrect, as although from 50 to 300 nuts may be seen ripening on the trees, they hang much longer than is generally believed. In the coral islands north and south of Samoa the trees do not attain the same girth as in the volcanic islands, while they also produce smaller nuts and take longer to come into bearing. Formerly much copra prepared from immature nuts was exported from Samoa; this was owing to the natives climbing trees and throwing down the nuts, a practice which has now been forbidden, with the result that Samoan copra is, perhaps, the best entering the Australian market. Cattle are employed to keep down weeds and manure the trees.

The insect pest, *Oryctes rhinoceros*, has appeared suddenly in Samoa (*Der Pflanzer*, 1912, **8**, 698), and was possibly introduced in some foreign timber. Regulations have been passed with a view to suppressing this pest, and the use of coconut palm stems for building posts, etc., is forbidden, as the dead wood harbours the larvæ; all dead palm trees and other breeding places must be destroyed, while premiums are offered for beetles or larvæ; and an offer of 20,000 marks is made for effective means of removing or restraining the pest. The young palms are chiefly attacked, and the natives hunting for beetles appear sometimes to cause more damage than the beetles themselves.

The entire issue of the *Philippine Agricultural Review* for May 1912 is devoted to coconut-planting and allied subjects; articles are given on soils and locations of plantations, varieties, pests, and diseases, copra and copra machinery, cover and secondary crops, etc.

A new pest, *Promocotheca cumingii*, attacking the leaves of coconut palms, has been discovered in the Philippine Islands (*Phil. Agric. Rev.* 1913, **6**, 105). The principal damage is caused by the larvæ, which mine the leaves, but the pupæ and beetles are also destructive. At present its occurrence is local, and it would be a serious pest but for the fact that the eggs, larvæ, and pupæ are attacked by a hymenopterous parasite. The infested leaflets should be collected and destroyed.

Only 150 to 200 acres are under coconuts in Antigua (*West Ind. Bull.* 1913, **12**, 563). The plantations are on sandy soil deficient in organic matter, and the young trees suffer from lack of moisture and are also attacked by a scale insect, *Aspidiotus destructor*. Older trees are, however, healthy. Coconut-planting should become a minor industry

in the island, as about 1,000 to 1,500 acres of suitable land are available.

In Perak 73,120 acres were under coconuts in 1911 (*Perak Administration Rep.* 1911, p. 11). The whole delta between the Bernam and Perak rivers has been alienated, and this large area of jungle will shortly be cleared and planted.

Some of the coconut plantations in Fiji are twenty to thirty years old (*The Colony of Fiji*, p. 41), and when run in conjunction with cattle-rearing are very profitable. Hurricanes sometimes cause much damage, as they prevent the production of nuts for two or more years.

Ground Nuts.—From experiments at Cawnpore it has been ascertained that the cost of growing ground nuts on irrigated land amounted to 60 to 70 rupees per acre (*Rept. Cawnpore Agric. Station*, 1911–12, p. 41). Yields of 25, 30, and 36 maunds (1 maund = $82\frac{2}{7}$ lb.) per acre were obtained, and, assuming the nuts to be worth 6 rupees per maund, a return of 150, 180, or 228 rupees per acre was obtained (the crop actually sold at 8 rupees per maund). Even with hired labour it is considered that there is a very good margin of profit.

Less experimental work on ground nuts is now being carried out in Bombay, as fairly conclusive results have already been obtained (*Ann. Rept. Dept. Agric. Bombay*, 1911–12, p. 30). Spanish nuts on the Dohad farm in the Panch Mahals gave a crop of 2,070 lb. of dry nuts per acre, with only 8½ in. of rainfall in a famine year. The net profit was 127 rupees per acre when other crops largely failed or were destroyed by caterpillars. Considerable progress with ground nuts has also been made in districts not previously planted with this crop, particularly in South Konkan and Khandesh. In Konkan, where the nuts are grown for oil as well as food, the demand for seed for sowing amounted to 13,000 lb. in the 1912–13 season.

Ground nuts in German East Africa have been found to suffer from a disease which has caused considerable damage in some districts. Zimmermann describes the appearance of diseased plants in an illustrated article (*Der Pflanzer*, 1913, **9**, 59); they show yellowing and shrivelling of the leaves, but the cause of the disease has not yet been discovered.

Oil Palm.—The palm-oil factory of the Nord West Kamerun Gesellschaft has for the first time yielded a small profit (*Der Tropenpflanzer*, 1913, **17**, 92). It is considered advisable to improve the methods of working with a view to producing palm oil suitable for edible use. The yield of palm fruit from the trees was low owing to the drought.

In order to obtain regular germination of palm nuts it is recommended that the fruits should be allowed to

ferment for some days in a sack or box before planting out (*Der Pflanzer*, 1913, **9**, 141).

The use of nut-cracking machines is extending in the Ivory Coast (*Journ. d'Agric. Trop.* 1913, **13**, 42). The cost of the machines is somewhat high for natives, but some large firms are lending machines in order to increase the output of kernels. A company entitled the Société française des Huileries et plantations de la Côte d'Ivoire has been granted the right to work for thirty years large tracts of palm forest in the region of Sassandra. Other crops may also be cultivated.

Shea Nuts.—An article dealing with insects attacking shea trees appears in *L'Agriculture pratique des pays chauds* (1912, **12**, 436). *Cirina Butyrospermi*, A. Vuillet, a large moth of a rose-fawn colour, lays its eggs in masses the size of a walnut, containing between 500 and 600 eggs, on the shea trees, generally in the forks where the new shoots spring from the boughs. The eggs are laid early in July, and hatch out in four weeks. The larvæ entirely denude the trees of leaves; shea trees attacked in 1911 did not bear fruit in 1912. The caterpillars when mature are about 3¼ in. long, and are black, with either yellow or white and yellow markings. A parasite, *Anastatus Vuilleti*, has been discovered on the eggs, but it only attacks the outer layer of eggs in the clusters; while a hemipterous insect, *Afrius purpureus*, Westwood, also attacks the young larvæ. The collection and destruction of the eggs or pupæ is suggested as a means of suppression. The adult larvæ are eaten by the Bambara natives.

The caterpillar of a microlepidopter of the family *Pyralidæ*, genus *Bostra*, may cause damage. The fruiting of shea trees is seriously hindered in some years by the attacks of locusts, particularly *Pachytylus migratoroides*, Reiche, which is widely distributed in Africa.

The larvæ of *Mussidia nigrivenella*, Ragonot, have been found attacking the nuts at Koulikoro.

Soy Beans.—The varieties of soy beans found in Bengal, Bihar, and Orissa are described by Woodhouse and Somers Taylor in *Memoirs of the Dept. of Agric., India, Botanical Series* (1913, **5**, No. 3), and the commercial possibilities of the varieties are also discussed. The authors record the results of a large number of selection experiments which they have carried out with a view to obtaining early-maturing types rich in oil, and also deal briefly with the cultivation and uses of soy beans. Soy beans are, however, unpopular as a crop in these districts for a number of reasons, among which may be mentioned the low export prices and the fact that the plants occupy land for two seasons in the plains; moreover, they are liable to be waterlogged in the rains, while they need moisture in

October. Satisfactory yields have, however, been obtained at several agricultural experiment stations, and it is considered that cultivation of soy beans would extend if better prices were obtainable.

Miscellaneous.—The seeds (kernels?) of *Canarium polyphyllum*, a tree which is distributed over the whole of New Guinea, and is very plentiful, contain 68·2 per cent. of fat suitable for edible use (*Der Tropenpflanzer*, 1913, **17**, 147). The residual cake is rich in protein, and feeding trials show that no poisonous substances are present.

The *Bull. Agric. Congo Belg.* (1912, **3**, No. 3) contains accounts of some new or little known oil seeds of the Belgian Congo. The "Utelo" (p. 645), an unidentified plant of N. O. Cucurbitaceæ, with long, straggling stems, possesses spherical fruits, which mature three months after sowing, and yield seed from which the natives prepare an edible oil. "Okoto" trees (*Pentadesma butyracea*) (p. 573) occur in the Kalako-Kombe district, but are not so plentiful as the "Usudi" trees, the botanical identity of which is at present undetermined. The seeds of both these are used for the preparation of edible fat.

The seeds of *Bauhinia esculenta*, Burch., known to the natives of German South West Africa under the names "Ombanui" or "Ozombanui" (*Der Tropenpflanzer*, 1913, **17**, 177), are cooked and eaten. They contain 39·0 per cent. of proteins and 43·32 per cent. (calculated on dry material) of non-drying oil, which has a pleasant taste and is edible.

The demand for chaulmoogra oil has increased of late years. According to Pearson (*Indian Trade Journal*, 1912, **27**, 203) the chaulmoogra tree (*Taraktogenos Kurzii*) is abundant in Burma, being fairly plentiful in the Shwegyin Division, where about 10,000 lb. of seed is available; as an experiment, the Forest Department collected 140 lb., at a cost of 3 annas per lb. The tree is also found in Assam and Chittagong, and the seeds are brought down to Sylhet and Surmaganj by traders from the Khasi hills and elsewhere. The seeds ripen in June and July, and enquiry for supplies of seed should be made in March or April to the Divisional Forest Officer of Shwegyin, Lower Burma; or of Sylhet and Sibsagar, Assam; or of South Malabar, Calicut, Madras.

Essential Oils

Marjoram and Origanum Oils.—In a series of articles in the *Perfumery and Essential Oil Record* (1913, **4**, 7, 41, 69, 136) the botanical sources of some of the commercial marjoram and origanum oils are discussed. The species defined and fully described are *Origanum majoranoides*, Willd., *O. Maru*, Linn., *O. Onites*, Linn., *O. hirtum*, Link., *O. vulgare*, Linn., *O. floribundum*, Munby, and *O. compactum*, Benth., the last three being at present of no commercial importance.

The author, Mr. E. M. Holmes, F.L.S., concludes that the perennial *O. majoranoides* and the annual *O. majorana* are probably merely forms of *O. Maru*. He states, however, that it is difficult to account for the fact that the oils said to be distilled from *O. majorana* and *O. Maru* (this BULLETIN, 1913, **11**, 50) contain no carvacrol, while that derived from *O. majoranoides* has a high carvacrol content, unless *O majoranoides* be regarded as a distinct species. The oil of *O. Onites* also contains a high percentage of carvacrol, while that of *O. hirtum* has a high thymol content (cf. this BULLETIN, 1911, **9**, 388). An editorial note appended to the last article gives descriptions of the various marjoram and origanum oils which have appeared in the English and Continental markets.

Rusa Oil.—In the *Indian Forester* (1913, **39**, 149), an account is given of the Rusa (*Cymbopogon Martini*, Stapf) oil industry, as carried on in the Melghat Division of the Berar Circle, India. The right to distil the oil is put up to auction by the Forest Department, and the lessee appoints agents who carry out the distillation and supply the oil to him at a fixed rate of 5 Rs. per seer (30s. per gallon). Primitive copper stills of 40 to 50 gallons capacity are employed. The inflorescence only of the grass contains the odorous oil, the stem being valueless. One-third or one-half of the stem, however, is cut, in addition to the inflorescence, to enable the grass to be tied into bundles, but this practice occasions a larger consumption of fuel than would otherwise be necessary for the distillation. The yield of oil per season of 100 days for a distillery of four stills is estimated at 172½ gallons, of which 160 gallons is obtained from the first cutting of 60 tons of grass, and 12½ gallons from the second cutting of 15 tons. It is estimated that the Government lessee realises a profit of 2,775 Rs. (£185) per distillery of four stills.

Miscellaneous.—In the *Perfumery and Essential Oil Record* (1913, **4**, 96), a new aromatic grass oil derived from *Elionurus tripsacoides*, H. B. and K., is described. It somewhat resembles vetiver oil in odour, and possesses the following physical constants: specific gravity 0·976; optical rotation $-10°$. On account of the high boiling-point of the oil the chief constituent is believed to be a sesquiterpene.

RUBBER

Hevea brasiliensis.—*Bulletin* No. 17 (1912), *Dept. Agric. Fed. Malay States*, by the Government Agricultural Chemist, contains a critical account of the methods employed in the preparation of plantation Para rubber, and describes numerous experiments made by the author. Tables are given showing the minimum quantities of various agents necessary to produce complete coagulation of the latex;

also the effect of adding increasing quantities of the coagulant.

The influence of the chemical nature of the coagulant is also discussed. Acids give the best results, and, according to the author, the quality of the rubber appears to be independent of the nature of the acid, any difference being due to the quantity of acid used. Acetic and formic acids are the cheapest and most convenient; sulphuric acid is also excellent when used in proper proportion, and hydrofluoric acid produces a pale rubber. Salts are unsatisfactory coagulants, aluminium, iron, and especially copper salts having a deleterious action on the quality of the rubber. Calcium and magnesium salts are not only apt to cause local coagulation, with corresponding lack of homogeneity in the rubber, but also assist oxidation by enzymes and consequent darkening of the rubber; moreover, calcium and magnesium chlorides are hygroscopic, and unless they are thoroughly removed by washing, it becomes impossible to dry the rubber completely. Sodium and ammonium bisulphites will coagulate latex if added in large quantities, and produce a pale rubber, but the same effect may be obtained by using smaller amounts of these salts in conjunction with acetic acid. Dilute solutions of coagulants are preferable to concentrated solutions, as there is less risk of local coagulation or "clotting"; but if the latex is diluted beyond a certain limit, the minimum quantity of coagulant necessary for coagulation increases, and the rubber produced is much softer and weaker; indeed, beyond certain dilutions the rubber becomes so soft and non-cohesive as to be difficult to handle. The time occupied by the coagulation appears to affect the quality of the rubber; slow coagulation, with a quantity of coagulant not much in excess of the minimum necessary to effect complete coagulation, produces the best rubber; rapid coagulation, with excessive quantities of coagulants, produces certain defects such as air-bubbles and "coagulation marks." If the rubber coagulum is removed from the serum as soon as coagulation is effected, it is found to be very soft and very difficult to handle, whereas if it is allowed to stand overnight in the serum, which is usually done, the clot contracts to form a firmer and more cohesive mass, and the rubber has probably better mechanical properties. Many substances inhibit coagulation: borax and sodium acetate prevent coagulation by acids; aluminium sulphate no longer coagulates latex in presence of alkali; and the coagulating effect of magnesium, barium, and calcium chlorides is also inhibited by alkalis. A mixture of calcium or magnesium chlorides with alkali favours rapid oxidation of the rubber.

Iron salts have a deleterious effect on rubber, assisting the oxidation process and producing "tackiness," hence the importance of the absolute cleanliness of the iron surfaces

of collecting cups, machinery, etc., which are likely to come into contact with the latex or rubber. The author also conducted some experiments on the effect of sunlight in producing "tackiness," but did not fully investigate the exact nature of the change (cf. this BULLETIN, 1912, **10**, 674). Copper salts were also found to rapidly produce tackiness in rubber.

The ordinary darkening of rubber is due to the action of an oxidase on oxidisable substances present in the latex, and the author was able to increase the darkening effect by adding amidol or phenol to latex. The oxidation, and hence the darkening, is arrested, and a perfectly white rubber, which does not darken on drying, is obtained (1) by coagulating in presence of sodium bisulphite; (2) by excluding air during coagulation; (3) by heating the latex to 80° C. by steam, or by immersing the washed sheet for a few minutes in boiling water, this treatment destroying the oxidase, and therefore preventing subsequent oxidation. The growth of moulds and bacteria on rubber is best prevented by smoking, or, in the case of pale rubber, by quick, careful drying, preferably in an atmosphere of carbon dioxide. The usual antiseptics either cause darkening of the rubber, or are not sufficiently retained after washing to be effective, or, as in the case of copper salts or mercuric chloride, they adversely affect the quality of the rubber.

The various patent coagulants are described, and smoke houses, drying sheds, collecting vessels, and machinery are discussed.

A table is given showing the specific gravity of latex at different concentrations. The author has also determined the viscosity of solutions in benzene of forty-nine different samples of plantation Para rubber at different concentrations. The results are tabulated and discussed. He concludes that for one species of tree there is a distinct relation between the viscosity curves and the physical quality of the rubber.

Some results of tapping experiments with *Hevea brasiliensis* at Ongiêm, Indo-China, are given in the *Bull. Économ. de l'Indochine* (1912, **15**, 162). Three trees, 4 years old, with a girth of 53, 50, and 45 cm. respectively, at a height of 1 metre, tapped daily from August to November 1911, on the half herring-bone system, gave an average daily yield of 1·84 grams of dry rubber per tree. Twenty-two trees, aged 12 years, tapped daily on the half-spiral system from April to December 1911, gave an average daily yield of 8·45 gms. dry rubber per tree. One hundred and twenty-eight trees, tapped daily on the half herring-bone system from April to December 1911, gave an average daily yield of 4·91 gms. dry rubber per tree. Forty-five trees, 11½ years old, but badly developed, tapped daily on the half herring-bone system from April to

December 1911, gave an average daily yield of 3·8 gms. dry rubber per tree. Twenty trees, 12 years old, tapped daily on the herring-bone system from April to December 1911, gave an average daily yield of 7·2 gms. of dry rubber per tree; another lot of eighty-eight trees of the same age, but in another situation, tapped by the same method during the same period, gave an average daily yield of 5·2 gms. dry rubber per tree. Tables are given showing monthly yields of rubber and latex; also the percentage of rubber in the latex each month for each experiment. The general mean rubber content of the latex was by the half-spiral method 32·6 per cent., by the herring-bone method 28·8 per cent., by the half herring-bone 27·6 per cent.

Bulletin No. 3, 1913, *Dept. Agric. Ceylon*, contains an account by the Government Entomologist of the stem and root borer of Hevea (*Batocera rubra*). Although Ceylon has not suffered much from this insect, several deaths of Hevea trees have been traced to it, and as a single grub may kill a tree and one beetle may infect several trees, the insect may become a pest. The symptoms of attack are usually obscure. When the injury is below ground the first intimation may be the collapse of the tree, or in sheltered situations the trees may gradually die and dry up. The method of entry is uncertain; the author is inclined to believe that the normal mode of entry is through a diseased area of the bark. Sometimes the injury is confined to the outer parts, at other times the grub bores right into the heart of the tree. A full description of the insect and its life-history, as far as it is known at present, is given. As remedial measures, the author recommends guarding the possible sources of entry by cutting out all diseased patches, tarring all exposed surfaces, and killing the beetles.

Dr. A. A. L. Rutgers publishes a preliminary account of investigations on "Hevea canker" in Java, Sumatra, and Borneo, in the *Mededeelingen van de Afdeeling voor Plantenziekten* (No. 2, 1912) *Departement van Landbouw, Nijverheid en Handel, Buitenzorg*. The first sign of the disease is the cessation of latex flow. In the outer layers of the bark claret-coloured patches are seen when the corky layers of the bark are shaved off. In many cases these patches begin at the cuts and run downwards. A discoloration of the inner layers of the cortex just outside the cambium sets in. This starts from the claret-coloured patches, but extends over a larger area, and subsists after the disappearance of the patches. Woody tissue is formed round the dead brown cells in the inner cortex, by the action of a secondary or wound cambium. This formation of wood in the cortex goes on for several months, and perhaps for years, after the canker infection is over. To get rid of the disease the author suggests that by all

possible methods the humidity of the plantations should be lessened, and free access given to air and sunlight. For this purpose, removing the intercrops, thinning out and pruning the trees, or draining may be necessary. All diseased parts of the cortex should be thoroughly removed without damaging the cambium, and the stems sprayed with Bordeaux mixture. The tapping-knives should be disinfected with formalin. In the same Journal (No. 3, 1912) Dr. K. W. Dammerman describes the occurrence, hitherto unsuspected, of *Termes Gestroi* in Java. A full description is given of the pest and its habits, as well as directions for dealing with it. The paper concludes with a list of other trees attacked by this insect.

Teysmannia (1913, **23**, 784) mentions a new leaf disease of *Hevea brasiliensis* discovered by Dr. J. Kuyper. It is due to a species of Fusicladium (*F. macrosporium*), and occurs all over Surinam. It shows itself in olive or dark-green spots, which appear on the young leaves, the leaves eventually becoming black and dying. It appears, however, that only young and weak trees are attacked, and the damage done on the whole is not serious. *H. guyanensis* is also affected by the disease, and in some cases six-year-old trees have been attacked and killed. In nurseries the fungus is apt to be destructive, and for that reason the beds should not be too thickly planted.

In *Der Tropenpflanzer* (1913, **17**, 63, 119, 181) Dr. S. V. Simon describes tapping experiments made with *Hevea brasiliensis*, with special reference to the formation of latex, renewal of bark, and the behaviour of the reserve food stuffs. The experiments were carried out at Buitenzorg on twelve trees 5½ years old, previously untapped. Every tree was tapped on one side in the ordinary manner with a knife, and on the opposite side the pricker was used in addition to the knife. The pricked areas afforded high yields at the first tappings, whereas the areas tapped with the knife alone gave measurable quantities of latex only after the sixth tapping. Very soon, however, the knife-tapped areas gave quite as much latex as the areas tapped with both the knife and pricker. Tables showing the yields of dry rubber from each tree per tapping are given, and the conclusion drawn is that, provided tapping with the knife is carried out to a sufficient depth of bark, the additional use of the pricker gives no increased amount of latex. A detailed description, illustrated by diagrams, is given of the anatomy of the bark of *H. brasiliensis*. Diagrams are also given showing the anatomy of the renewed bark when tapping is done with the knife alone, and when the pricker is also used. The author concludes that for six months after the pricker has been used the regular migration of foodstuffs is impeded, and may be partly stopped altogether; if, however, the knife alone

is used for tapping, sieve-tubes are re-formed within a month, which in no way differ from those in the untapped bark, so that after that period a normal migration of foodstuffs occurs. At the same time there are formed directly under the surface of the exposed bark tissue one or more thick layers of stone-cells which, after one month, have attained considerable extent, and afford effective mechanical protection. When the pricker is used, however, at every perforation there develop strong agglomerates of stone-cells which extend to the cambium, and impede the formation of connected laticiferous vessels. According to the author the best tapping methods are those which, with the smallest cut, drain the largest area of bark, as, for example, tapping opposite quarters simultaneously. If the distance between the original cuts is made such that it takes two years to complete the two quarters, the bark will have four years for renewal, which, according to his results, is ample. By studying the distribution of the carbohydrates the author also concludes that ordinary knife-tapping causes no drain on the reserve foodstuff in the wood below the tapped area.

General.—*The Insoluble Constituents of Ceara and Rambong Rubbers* is the title of a paper by C. Beadle and H. P. Stevens in the *India Rubber Journal* (1913, **45**, 313). On treatment with a large excess of benzene Ceara and Rambong rubbers behave exactly like Hevea rubbers, swelling up until the whole of the benzene is absorbed by the rubber, which on further standing contracts, forming an upper clear solution and a lower opaque layer containing the insoluble matter. In Ceara rubber, as in Hevea rubber, the insoluble portion contains almost the whole of the nitrogenous matter; in the case of Rambong rubber, however, a considerable portion of the nitrogen is in the soluble part. On vulcanisation the Ceara and Rambong rubbers, after removal of the insoluble part, behave like Hevea rubber from which the insoluble portion has been removed, the percentage of combined sulphur being reduced and the resulting vulcanised rubbers being much undercured and weak. Similarly the effect of additional insoluble matter is to increase the proportion of combined sulphur. Contrary to their previous opinion (this BULLETIN, 1913, **11**, 162), the authors conclude that the insoluble matter of rubber plays the part of a sulphur-carrier and vulcanising agent, independently of the proportion of nitrogen it contains.

FIBRES

Sisal Hemp.—It has been observed that Sisal hemp, produced and baled in German East Africa, which is quite white when exported, on arrival at Hamburg sometimes contains fibres of a red colour. In many cases, the whole

consignment has been damaged in this way. Sisal planters in Java have had a similar experience. It has been established at the Bacteriological Institute of Buitenzorg, Java, that the red coloration is due to the action of bacteria. It is possible that the bacteria are already present on the fibre before it is washed, or it may be that the fibre is first infected by the water used for washing it. If the bales become damp by exposure to the rain and are shipped in this state, the conditions during transport are very favourable to bacterial fermentation. In order to avoid this injury, it is recommended (*Der Tropenpflanzer*, 1913, **17**, 83) that the water used for washing the fibre should be thoroughly disinfected: a system of tanks for effecting such disinfection is described.

Bamboo.—The chief material at present employed in the Indian paper-mills is the plant known as "Sabai" grass (*Ischæmum angustifolium*). For some years, however, considerable attention has been directed to the feasibility of using bamboos for the purpose, and reference to these investigations has been made in this BULLETIN (1909, **7**, 353; 1912, **10**, 676). A further report on the subject has been made recently by Mr. R. S. Pearson, Economist at the Forest Research Institute, Dehra Dun, and has been published as *Indian Forest Records* (1913, **4**, pt. v.), which is printed on paper made from *Bambusa polymorpha*. Although the Government of India have offered to grant concessions on very favourable terms, with a view to encouraging a bamboo paper-pulp industry, hitherto no firm or company has taken the matter up. Mr. Pearson's report has been issued in order to supply the necessary data to enable commercial undertakings to consider the possibilities inherent in this enterprise. Attention is directed to certain localities regarded as particularly suitable for the industry, of which five are situated in Burma, three in Bombay, and three in Madras. These areas have been inspected with great care, and information has been collected with reference to the number and species of bamboos available, and estimates made of the probable yield. Suitable sites for factories are indicated, and particulars are given of the cost of labour, transport facilities, and other local conditions. A large quantity of the raw material was sent to a paper-mill in India, where it was converted into pulp, and afterwards into paper. The report describes the species of bamboos available for paper-making in India, and their mode of growth, the methods of converting the stems into paper-pulp, and the cost of manufacture. Estimates of the outlay required for erecting and equipping a large paper-mill are quoted, and particulars are given of the chemicals required and their cost.

Cotton

A report on "The Effect of Water on the Cultivation of Cotton," published as *Survey Department Paper*, No. 24 (1912), *Ministry of Finance, Egypt*, gives an account of (1) an experiment, known as the Gemmeiza Strip Experiment, to determine the relation between the height of the water-table, or level of the sub-soil water, and the yield of cotton; (2) a comparison of the height of the water-table and the yield of cotton at several places in the Delta during 1910 and 1911; and (3) a weir-discharge experiment to determine the quantity of water actually led on to a cotton-field. The results of (1) have shown that the yield of cotton increases steadily with the thickness of the layer of soil above the water-table; more flowers are produced, a larger proportion of the flowers develop into ripe bolls, and the weight of cotton per boll, the height of the plants, the weight of the individual seeds, and the number of seeds per boll all increase as the height of the water-table decreases. A rise of the water-table causes a diminution in the crop, but the actual effect of the rise depends on the time at which it occurs, the earlier the rise the greater being the damage. The observations (2) confirm the results of the Gemmeiza experiment, and show that the yield of cotton increases with the depth of the water-table until, at a certain depth, which varies from 3 to 6 ft. according to the locality, the yield tends to become constant. In experiment (3) the quantity of water flowing on to the land at the various waterings given was measured, and it was found that the average thickness of the layer per watering was 3·25 in., or about 72,000 gallons per acre. This is supposed to be rather less than the average quantity employed in agricultural practice. The rise of water in bore-holes in the experimental plot was usually about seven times the thickness of the layer applied to the land. These investigations demonstrate that the height of the water-table is probably one of the most important factors which determine the size of the cotton crop in Egypt.

The cotton worm, or cotton caterpillar (*Alabama argillacea*, Hubn.), was at one time one of the most destructive pests in the United States, but from 1890 to 1910 its ravages were comparatively small. A serious outbreak occurred in 1911, however, which originated in Central or South America. An account of the insect, and of the best means of dealing with it, has been published as *Circular No.* 153 (1912), *Bureau of Entomology, U.S. Dept. Agric.* The most effective method of control is to apply powdered lead arsenate in a quantity of 2 lb. per acre. The poison should be used as soon as any injury appears, except in localities where the boll weevil is abundant. In the latter case, the defoliation of the plants acts as a severe check to

the weevil, and, up to a certain point, the cotton worm is thus of distinct benefit to the crop; if, however, the leaves have been devoured to a great extent before the bolls are three-fourths grown, the lead arsenate treatment should be adopted.

In the *Bulletin of Entomological Research* (1912, **3**, 203), descriptions are given of *Gelechia gossypiella*, Sndrs., *Pyroderces simplex*, Wlsm. (=*gossypiella*, Wlsm.), and *P. rileyi*, Wlsm. Gelechia causes great damage to cotton by attacking the seeds in the boll. It is not at present known whether *Pyroderces* spp. cause any actual injury, but it is probable that they are associated with cotton already affected by damp or some other insects, rather than that they are themselves a direct cause of damage. *Gelechia gossypiella*, the pink boll worm, is widely distributed in Europe, Asia, and Africa. It is a very destructive pest in the Indian cotton-fields, but its occurrence in Egypt seems to have been overlooked until comparatively recently. An account of this insect has been given by Mr. G. C. Dudgeon, Director-General of the Department of Agriculture, Egypt, in the *Agricultural Journal of Egypt* (1912, **2**, 45). In 1912 the insect effected considerable damage to cotton in the north of Gharbia and Beheira Provinces. The larva feeds on the unripe seeds, but usually only destroys the seeds in one cell of the boll. The pest is no doubt harboured by the cotton stems, which are preserved for fuel and which bear numerous dried and diseased bolls affording ample protection for the moth and larva.

Great injury has been occasioned to cotton in German East Africa by the attack of a beetle (*Xanthoxylum* sp.). The eggs are laid on the top of the root, just at the point where the stem appears above the ground, and the young insects bore their way into the stem and pupate. The full-grown beetle is black, and about $\frac{1}{10}$ in. long. The pest is best controlled by spraying the plants with a mixture of Schweinfürth green with sugar and water, but care must be taken that as little as possible of the liquid falls on the leaves.

Cape Province.—Cotton-growing has been attempted from time to time in various parts of the Cape Province, but the experiments have been neither systematic nor adequately supervised. Moreover, a large part of the Province is not adapted to the crop. A trial has been made recently at Big Umgazi, in the district of Port St. John, Pondoland, where the conditions of soil, climate, and labour seem to offer good prospects. An account of this experiment is given in the *Agric. Journ. of the Union of S. Africa* (1912, **4**, 830). The varieties grown were Sea Island, Mitafifi, Nyasaland Upland, Toole, Cleveland Big Boll, and Herlong. The yields were excellent, and varied from 1,370 lb. of seed-

cotton per acre, in the case of Sea Island, to 810 lb. per acre, in the case of Herlong. The results are regarded as very satisfactory.

Northern Nigeria.—A tour of the Hadeija and Katagum Districts of the Zaria Province, Northern Nigeria, has been made recently by an officer of the British Cotton Growing Association. Cotton is grown on an extensive scale by the natives in certain parts of this region, the principal varieties being those known in the vernacular as "Chukwe," "Yargari," "Labei," and "Bazazaga." The plant is grown sometimes as an annual, and sometimes as a perennial; in the latter case, it is either ratooned or grown as a tree-cotton.

Ceylon.—A summary of the trials made in seven successive seasons (1903–1911) at Maha-iluppalama has been given in the *Tropical Agriculturist* (1913, **40**, 11). In four of these seasons the crops were either a partial or total failure, and in the remainder the yields were less than half the normal amount. These experiments have demonstrated that Maha iluppalama is unsuitable for Sea Island or Egyptian cotton and is not altogether satisfactory for American varieties The unfavourable results are due to a deficiency of rain during the planting and growing seasons and an excess of rain during the later periods, as well as to the employment of inferior seed, the ravages of insects and the prevalence of strong winds.

FORESTRY AND FOREST PRODUCTS

A considerable number of exotic trees have been in cultivation during the past thirty to forty years by the Forest Departments in various provinces in India. A list of the more important of these is given in *Forest Records* (1913, **4**, 3). With a view to realising the maximum economic benefit from the work done in the past, it is proposed to publish all available information regarding species that give promise of being important, especially of those that are likely to thrive in situations where native trees will not succeed. The first species to be dealt with under this scheme is *Prosopis juliflora* DC. (var. *glandulosa*, Sarg.), which is figured and described in the issue above quoted. This tree, a native of west tropical and subtropical North and South America, is a strongly xerophilous species, well adapted to dry soils and arid districts. It is likely to prove useful as a sand-binder and also as a pioneer in afforesting dry grass lands and waste areas where more valuable species will not thrive. Its pods are filled with a sweetish pulp and afford a useful fodder, especially in years of scarcity; its wood is also of considerable value.

Three trees inhabiting the Pacific Coast of the United States are dealt with in *Silvical Leaflets* Nos. 45, 51, and 52, 1912, *For. Serv., U.S. Dept. Agric.* They are respectively the Western hemlock, *Tsuga heterophylla*, Sarg.; the broadleaf maple, *Acer macrophyllum*, Pursh; and the Oregon oak, *Quercus garryana*, Dougl. The range and occurrence of each is fully described, together with the climate and habit, and the associated species. Particulars relating to these species, which will be of service in the raising of young trees for planting and re-afforestation purposes, are also given.

Forest Fires.—F. G. Plummer, in *Bulletin* No. 117, 1912, *For. Serv. U.S. Dept. Agric.*, deals with the causes, extent, and disastrous effects of forest fires. He has arranged and classified, from all available sources of information, data relating to forest fires in the United States, Canada, and Newfoundland, from 1820 to 1911. It is pointed out that forest fires in the United States alone have caused an average annual loss of about seventy human lives, the destruction of trees worth not less than 25,000,000 dollars, and the loss of stock, crops, buildings, and other improvements to the amount of many millions more. Enormous losses are also entailed from the destruction of young tree growth, deterioration of soil, damage to watercourses and adjacent property by low water and flood, interruption of business, and depreciation of property. In order of their importance the following are the chief known causes of fires in the national forests: railroads (sparks from engines), lightning, campers, bush-burning, incendiaries, and saw-mills. Droughts are the most notable of the contributory climatic causes of fires. There is an interesting account of the smoke phenomena resulting from forest fires, such as dark days, dry fogs, Indian summer, and coloured rains. The published statistics, which give a summary of destruction and loss, show the enormous damage caused by the depletion of forest resources through fires.

Insects injurious to "Babul" (*Acacia arabica*).—Considerable damage has been done during recent years to the babul plantations of Berar by two species of beetle which have been identified as *Cœlosterna scabrata*, Fabr., and *Psiloptera fastuosa*, Fabr. Both species, in the mature state, attack the bark of the leading shoots and branches of young trees, and in the case of the Cœlosterna, the grubs tunnel in the roots and kill young trees. The *Indian Forest Bulletin* (No. 12, 1912) contains figures and descriptions of these insects and an account of the damage done by them in the forest. The remedies suggested against the attacks of the Cœlosterna are to dig up and burn infested trees as soon as detected or to slit up the parts affected and destroy the grub nymphs or beetles that may be found. Infected trees may

readily be recognised by the injured bark of the shoots or by the wood-dust and excreta near the holes at the base. Further information is required in order to complete the account of the life-history of the Psiloptera.

Casuarina equisetifolia.—A description of the Casuarina plantations on the North Kanara coast of the Bombay Presidency is given in the *Indian Forester* (1913, **39**, 141), together with notes on the working plan. The Casuarina is grown entirely for fuel; the wood is hard and brittle, and burns well even when green. There are now 560 acres under the working plan, 360 of which are planted. The young trees are raised in nurseries, which are furnished with seedlings either from seed-beds or from open spaces and margins of the plantations, where they occur naturally. After about eight months in the nursery they are planted out 10 ft. by 10 ft. apart. The plantations are situated along the sea-coast; the soil is pure sand, with subsoil water at a depth of from 8 to 12 ft., or in some cases as much as 20 to 25 ft. below the surface. The rainfall from the beginning of June to November is practically *nil*, but during the monsoon it averages about 120 in. During the first dry season after planting the young trees are watered daily; by the second year they have usually become established. Experiments have shown that by inserting bamboo tubes about 1 ft. in length in the sandy soil near the roots of the young trees, and filling these with water every two or three days, the daily watering can be dispensed with. Growth is very rapid in the plantations, young trees only four and a half years old attaining a height of from 40 to 50 ft., and a girth at breast height of 1 ft. 5½ in. In accordance with the working-plan thinning should take place when the plantations are ten and twenty years old, but in practice it will probably be necessary to thin the best areas at eight, sixteen, and twenty-four years. The wood is all sent to Bombay, where it fetches a good price. The value of the yield per acre expected to be realised at thirty years is given as Rs. 324 (£20 5*s.*); the cost of planting per acre, with compound interest at 4 per cent. for the same period, is estimated at Rs. 81 (£5 1*s.* 3*d.*).

Timbers

Technical properties of Timbers.—Experiments have been conducted at the Civil Engineering College, Sibpur, to ascertain the amount of shrinkage that takes place in different species of timber while seasoning. The results of the first of these investigations are published in the *Indian Forest Bulletin*, 1913, No. 15; they refer to Toon wood (*Cedrela Toona*), a timber largely used for furniture making in Northern India. A machine has been devised for these experiments by means of which the amount of shrinkage

can be accurately measured. The experiments have established the fact that, while seasoning, Toon wood contracts considerably, and when seasoned it is liable to absorb atmospheric moisture, and to again expand. How long this process of contraction and expansion continues is not known, but probably for several years. The specimen planks used for the test decreased in breadth nearly 0·3 of an inch per foot in little over a year, and an additional 0·1 of an inch during the hot weather. This probably represents the limits of its contraction, as the moisture in the timber at this stage was found to be only 7·59 per cent. The importance of seasoning this timber is therefore evident. If converted in a green state it is suggested that the planks should season for at least one year, and if seasoned in the log at least eighteen months should be allowed.

The correlated results of all the tests carried out by the Forest Service of the United States on structural timbers, exclusive of round and other special forms, are included in *Bulletin* No. 108, 1912, *For. Serv., U.S. Dept. Agric.* While no attempt has been made to recommend the factors of safety which should be applied to the values given in the tables, the report should be of use (1) in determining working stresses and proper factors of safety in connection with the design of timber structures; (2) in studying the relation of the physical characteristics and defects of timber to its strength and other mechanical properties; and (3) in devising standard specifications and grading values for different forms of structural timbers.

The timbers tested were all members of the Coniferæ and comprised four pines, two spruces, two larches, a hemlock, a red-wood and a Douglas fir, whilst the methods employed were those described in *Circular* No. 38 of the same Service—they included bending and shearing tests, and compression tests parallel and perpendicular to the grain. A comparison of the results of tests on air-seasoned material with those on green material shows that, in general, all the mechanical properties are increased by seasoning—this is especially marked on small pieces free from defects. In the case of large timbers, the increase in strength of wood fibre due to drying is largely offset by the weakening of the timber due to the formation of cracks. If, however, a piece of seasoned timber becomes wet it loses strength rapidly, and when soaked with water will become weaker than when green. The paper is well furnished with tables of the results of the individual tests.

Strength of Teak.—Experiments to compare the strength of teak grown naturally, with that produced in plantations, have been referred to previously in this BULLETIN (1911, **9**, 311, and 1912, **10**, 327). The results of further work in this connection, published in *Indian Forest Bulletin*, 1913, No. 4, confirm the conclusion previously

arrived at that plantation teak is equal in strength to that from natural forests; they also show that the percentage of moisture in the teak has no marked effect on its strength, when compression and shearing tests are applied, but it appears to have a considerable effect when the timber is subjected to transverse strain. Further, they indicate that there is practically no difference in the strength of teak seasoned standing after being girdled, and when felled and seasoned in the log. Care was taken to ensure that the specimens of timber selected for these experiments were from trees of equal age.

Tanning Materials

Acacia spp.—An account of the species of Acacia found in Senegal which yield tanning materials, viz. *A. arabica*, *A. arabica* var. *adansonia*, *A. Seyal*, *A. Sing*, and *A. albida*, is given in *L'Agric. prat. des Pays chauds* (1912, **12**, 177). The first two are the most important, their barks containing about 20 per cent. of tannin on an average. Such bark might be used locally for the manufacture of tanning extract, but it would not be profitable to export it in the crude state. The pods are more valuable, and contain on an average 20 to 30 per cent. of tannin (compare this BULLETIN, 1906, **4**, 96; 1907, **5**, 358), but it is stated that the tannin content of unripe but full-sized pods is 40 per cent. against 20 per cent. for ripe pods. The pods should be dried before packing, otherwise they deteriorate on keeping. The trees do not bear fruit abundantly until about fifteen to twenty years old, and then give a yield of 80 kilogrammes (176 lb.) of pods per tree. The crop varies with the locality, the duration of the floods, and the abundance of the rains. The pods are collected several times a year by the natives, who generally wait for them to ripen, as it is easier to collect them then, than to cut down the branches, as is necessary in the collection of the unripe pods.

The pods are used chiefly for tanning purposes, and might be exported. The native methods of tanning with these materials are described. The wood of these acacia trees is resistant to termites, and is used as fuel and for making charcoal.

The Acacia forests in Senegal are only half their original size, as they have been much destroyed through careless exploitation during the last twenty years, in spite of various forest laws which have been passed from time to time, but which have not proved effective, owing to the lack of proper supervision.

Sumach.—The cultivation of sumach in Sicily is now less remunerative than formerly, owing to the fall in price of this tanning material. Sumach cannot be reproduced from seed in South Europe, and cuttings have to be used for propaga-

tion. Directions for planting and for the preparation of the soil are given in *Collegium* (1912, No. 512, p. 699). The largest crop of leaves, which is generally about 16 quintals per hectare (= 12·8 cwt. per acre) is obtained in the third year after planting. The price of sumach varies in the different districts according to the variety, the method of cultivation, and the nature of the soil in which it is grown. The average profit per hectare is given as 80 to 100 francs (= 26*s.* to 32*s.* per acre). This tanning material is often adulterated with lentisk leaves, and the restrictive measures adopted by the Government against such adulterations have as yet not been effective.

Wattle Bark.—According to the Report of the Trades Commissioner for South Africa (1911, p. 32), the continued increase in the output of wattle bark must lead to a fall in price. Attention has already been called to this subject in this BULLETIN (1911, **9**, 116). The export statistics for 1911 show that out of the 50,000 tons of bark exported, Germany took about 30,000 tons, and although a large quantity was shipped to the United Kingdom, only a small percentage was consumed in this country. It is suggested that a larger market could be found in the United Kingdom for this material in the form of extract. Further enquiries showed that wattle extract could be profitably manufactured in South Africa, and it is advised that the extract take the form of "crystals" containing not less than 60 per cent. of tannin. The estimated cost of a complete plant to treat 75 tons of bark per week is given as £10,000 f. a. s. Glasgow, or to treat double the quantity as £15,000.

Miscellaneous,—An artificial tanning material has been prepared and put on the market by Dr. E. Stiasny, of Leeds University, under the name of "neradol." This material is a condensation product of formaldehyde and a phenol, such as cresylic acid, and details of its preparation are given in *Collegium* (1913, No. 516, p. 142). It is claimed that "neradol" is easily and completely soluble in water and forms a pale-coloured solution, which gives reactions similar to those afforded by tannin solutions from vegetable sources. Its tanning properties are said to be satisfactory.

Resins

Lac.—Experiments with lac insects (cf. this BULLETIN, 1912, **10**, 508) have been continued in Ceylon with a fresh supply of sticks carrying these insects, which have been received from India (*Trop. Agric.*, 1912, **39**, 379). They have been attached to "masan" trees (*Zizyphus jujuba*) in the Royal Botanic Gardens at Peradeniya, and also at Tangalle and Ambalantota. The larvæ have settled down in the case of the first two places, but at Ambalantota

success is doubtful, as nearly all the larvæ had emerged before the trees were inoculated. Further experiments are to be carried on with "kon" (*Schleichera trijuga*) and "rain" trees (*Pithecolobium Saman*).

Turpentine.—The tapping experiments with "Chil" pines (*Pinus longifolia*), begun in 1910 (see this BULLETIN, 1912, **10**, 507), were continued during the year 1911–12 (*Prog. Rep., For. Admin., Punjab*, 1911–12, p. 9). The experiments, carried on with the object of comparing the French and American methods of tapping, have now been abandoned, as the natives were not sufficiently expert to cut the American type of blaze on a large scale. Although this blaze, from 9 to 14 in. wide, causes unnecessarily large wounds, as compared with the French type, the experiments showed, as far as they went, no appreciable difference in the yield of oleo-resin. No results are yet available as to the number of blazes required according to the girth of the tree tapped. Observations have shown that trees that have been "tapped to death" give a much greater yield than trees tapped in a less drastic fashion, the increase in yield varying from 2½ to 6 times the ordinary yield, according to the girth of the trees. It is suggested, therefore, that all trees marked for felling should be "tapped to death."

The most economical freshening period has been shown to be 3 days, against 7 days in the United States and the United Provinces, and against 5 days, the time now allowed in the Punjab.

The factory at Shahdara has been working throughout the year, and experience shows that the present plant can deal with a maximum of 13,000 maunds (478 tons) of crude oleo-resin annually. Larger plant is now being erected, so that this industry may be developed to the fullest extent. The tapping has up to the present been confined to the "Chil" pines in the Rawalpindi Division, but as soon as the large stocks of oleo-resin at the factory have been worked off, the field will be extended to the Kangra Division. Experimental work has been started on a small scale in Bashahr Division with *Pinus excelsa*, to ascertain if it is profitable to tap this pine.

The results of tapping experiments in the western United States of America have shown that nearly as much turpentine oil and rosin can be obtained from the western yellow pines as from those of the east, but without a trial on a commercial scale it is not possible to state whether the exploitation of these western pines can be profitably carried on (*Bulletin* 116, 1912, *For. Serv., U.S. Dept. Agric.*). The oil obtained from this new source is slightly different in composition from that from eastern pines, but it is stated that it would nevertheless be suitable for industrial purposes.

The industry of utilising saw-mill waste and light wood

of the long-leaf pine as a source of turpentine oil was first started in 1903 in the United States of America, but has declined in the last few years as it was found not to be very profitable. The waste wood was submitted to distillation with steam and a crude "oil of turpentine" was produced. A number of experiments with this process have been carried out (*Bulletin* 109, 1912, *For. Serv., U.S. Dept. Agric.*), and the tabulated results show the most economical methods of working this process under given conditions, governed by the kind of wood waste, whether sawdust or chips, the pressure and cost of steam, and the value of the products. The authors consider that this process is profitable, especially if a market can be obtained for the chips after distillation, *e.g.* as a source of rosin.

Mr. Puran Singh deals with the distillation and composition of turpentine oil from "Chil" oleo-resin in *Indian Forest Records* (1912, **4**, 1). An account is given of trials with different methods of distillation, and the commercial valuations of the resulting oils, together with their chemical composition. There would appear to be a considerable demand for turpentine oil in India, and it is stated that there is every possibility of a ready market for the Indian oil, and this industry should therefore be extended. The author also gives a short note on various methods of decolorising Indian rosin.

ECONOMIC MINERALS

Copper Ore.—In *Report* No. 1, *Geol. Surv. S. Australia* (*Dept. of Mines, Adelaide*, 1912) L. K. Ward and R. L. Jack deal with the Yelta and Paramatta mines, which lie within a radius of two and a half miles to the east and north-east of Moonta. The igneous rocks of the district are described as the older felsites and felspathic porphyries, which are in part schistose, and are traversed by the younger pegmatite dykes. The only consolidated sedimentary rock is a quartzitic conglomerate. These constitute the bed-rocks of the area, and are covered by a mantle of travertine, clay, and sand.

The ores are carried by the pegmatites, in which they occur as original constituents. The minerals present in the unaltered pegmatites are quartz, biotite, microcline, tourmaline, and fluorite, with chalcopyrite, bornite, hæmatite, pyrite, and molybdenite; there are also traces of gold, silver, and bismuth. In the oxidised surface zone the chalcopyrite has been in some cases partly altered to tenorite, and more rarely to covellite. Other secondary minerals present in this zone are limonite and molybdic ochre. Malachite and atacamite appear to be generally absent, a fact which has had a deterrent effect upon prospecting.

According to the *Review of Mining Operations in the State of S. Australia during the Half-year ended Dec.* 31, 1910, the Yelta and Paramatta mines were purchased by the South Australian Government in 1910, the sum of £6,000 being paid for the property, which covers 1,349 acres. For some years before they were closed in 1907 the mines were worked by a French company, and produced £250,000 worth of copper between 1903 and 1907. In the same *Review* for the half-year ended June 30, 1912, H. Conder, in a report on the Yelta mine, states that a southern branch of the main shoot has not been depleted, and that it should provide some 6,000 tons of 5 per cent. ore, which can be mined and smelted at a cost of 35*s*. per ton, leaving a profit of about £6,000.

Gold Ore.—*Bulletin* No. 45, *Geol. Surv. Western Australia*, gives an account, by H. W. B. Talbot, of geological investigations in the country lying between latitude 28° and 29° 45′ S., and longitude 118° 15′ and 120° 40′ E., embracing parts of the North Coolgardie and East Murchison goldfields. The greater part of the region is occupied by granite, though there is a considerable area occupied by "greenstones," which are chiefly of epidiorite type. The greenstones are associated with ferruginous quartz schists, and form a series of ridges or belts, of which there are seven of large size and a few smaller ones in the area dealt with. At various localities in the greenstone areas there are numerous acidic dykes, and these localities are considered to be of special importance to gold-prospectors, since such acidic intrusions have been found to exert a marked influence on the deposition of gold in various parts of Western Australia.

In *Bulletin* No. 46 of the same survey H. P. Woodward gives a general description of the northern portion of the Yilgarn goldfield, and the southern portion of the North Coolgardie goldfield. The general geology of this area is much like that of the area described in *Bulletin* No. 45, the predominating bed-rock being granite. The oldest rocks are granites and hornblende schists; these are cut by later granites; and there is a still later series of basic dykes. Outcrops are scarce, for the surface is mostly concealed by sands, loams, and clays which have arisen from the decomposition of the igneous rocks *in situ*. The gold-bearing veins or lodes occur in the schists, and are of two types, viz. quartz reefs proper, and banded ferruginous quartzite ("jasper bars").

The quartz reefs have proved to be very rich near the surface, but they rapidly decrease in value below the water-level, and pass into large pyritic masses of low-grade character. The "jasper-bar" type of ore-body is often rich in gold in the oxidised zone, especially where veins of secondary silica are most abundant. Below the

oxidised zone there is a sudden change in the character of the rock to a greenish and pyritic quartz-schist, in which the gold values are dependent on the presence of intersecting quartz veins or zones of dislocation. In other parts of the States, these bodies have been found to pass at greater depth into chloritic schists, from which it is inferred that both the pyrites and quartz are secondary minerals, and that the gold has been deposited from circulating ground waters by sulphate of iron arising from the decomposition of pyrites. In the dry rock below the zone of saturation no gold-ore occurs.

The gold production of the Federated Malay States for 1912, as reported to the Secretary of State for the Colonies, is as follows:

	oz. (troy).	Value at £3 17s. 6d. per oz.
Gold exported from the Federated Malay States . .	12,533	£48,565
Gold reported to have been bought by buyers in Perak	1,888	7,316
Total	14,421	£55,881

This shows an increase of 5192·7 oz. as compared with 1911, in which year the total production was 9228·3 oz., valued at £35,760.

Pyrites.—In "Pyrites in Canada" (*Mines Branch, Dept. of Mines, Canada*, 1912) A. W. G. Wilson gives an account of the Canadian occurrences of pyrites, and deals with the exploitation, dressing, and uses of the mineral. Pyrites is widely distributed in Canada, but its mining as a sulphur ore is confined to Ontario and Quebec.

In Ontario pyrites is stated to occur throughout an area of approximately 170,000 square miles, including Eastern, Northern, and Western Ontario. At Queensboro mine, Hastings Co., the pyrites occurs at and near the contact of a light-grey granite with a garnetiferous schist. The highest-grade ore comes from a series of lenses close to the contact. One of these lenses is traversed by the main shaft, and shows a width of 15 ft. at the shaft, and a length of about 50 ft. The iron pyrites in these lenses is hard and massive, the only impurity being thin veinlets of quartz. Shipments have averaged 47 per cent. of sulphur. At this mine there are extensive bodies of rock impregnated with pyrites, from which 35 per cent. sulphur ore can be quarried. Elsewhere in Ontario pyrites deposits occur in the pre-Cambrian gneisses and crystalline limestone, calcite being a notable impurity of the ore in some cases; and at the Helen mine, near Lake Superior, the pyrites occurs in the form of lenses in and near a body of hæmatite ore. The producing mines in Ontario are at Hungerford and Madoc in Hastings Co. The Helen iron mine, about 15 miles north-east of Michipicoten harbour, Lake Superior,

also produces pyrites, and shipments of ore from this mine contain 42 per cent. or more of sulphur.

Pyrites is also produced at Eustis and Weedon in Quebec. At the Eustis mine the ore-body consists of a series of huge lenses dipping at an angle of about 35° to the south-east. The pyrites shipped contains from 40 to 45 per cent. of sulphur, and a little chalcopyrite. The ore usually contains less than 2 per cent. of copper; it is free from arsenic, and of good quality for sulphuric acid manufacture. It is estimated that more than 500,000 tons of ore have been obtained from this mine. The ore mined at Weedon is richer in copper, and a considerable tonnage of ore, carrying about 5 per cent. of copper in addition to the sulphur, has been shipped.

During 1911 the output of pyrites in Canada was 82,666 short tons, valued at $365,820; of this, 32,102 tons, valued at $120,585, was exported; but during the year 25,281 short tons of sulphur, valued at $524,473, was imported.

Tin Ore.—*The Geology of the country round Warmbaths and Nylstroom, including the Rooiberg tin-fields* (Pretoria, 1912), is an explanation of Sheet 10 (Nylstroom) of the geological map of the Transvaal, by H. Kynaston, E. T. Mellor, and W. A. Humphrey. The greater part of the area described is occupied by the red granite of the Bushveld, and rocks belonging to the Waterberg system, including felsitic lavas and the quartzites and shales of the Rooiberg series.

The Rooiberg tin-field is roughly triangular, and consists of sedimentary rocks (quartzites and shales), bounded on the west by the granite of Boshofsberg, on the north by the felsites of the Elandsberg, and on the east by the felsites of the Rooiberg hills. The sedimentary rocks are overlain by the felsites, while the granite is intrusive in both, and almost completely surrounds the tin-field. The structure is simple, the sedimentary rocks exhibiting a slightly folded character. On the whole the dips are low, ranging from 5 to 10°.

Tin ore deposits have an extensive distribution in the area dealt with. They can be roughly divided into two main groups—(1) those associated with the granite-felsite contact; (2) those associated with the Rooiberg series, which are the more important of the two, and which are also doubtless connected with the intrusion of red granite, though this connection is not so obvious as in the former group.

The deposits associated with the granite-felsite contact show considerable variety. The tinstone occurs either in the granite itself, or in the felsites, at varying distances from the contact, but never far from it, and has been found in varying quantities on practically every farm situated within the zone from Zwartkloof, near Warmbaths, to the north-western portion of Rhenosterhoekspruit, on the Hoekbergen.

The ore deposits along this contact appear to be generally of an ill-defined type, and are irregularly distributed. Among the minerals associated with the tinstone are tourmaline, fluorite, pyrite, chalcopyrite, and galena.

The tin ore deposits associated with the Rooiberg series are of a richer type, and the Rooiberg mine has now become one of the foremost tin-producers of the country. The system of lodes here worked intersects the quartzite of the Rooiberg series, and is comparable to a stockwork on a large scale. The deposits are scattered over a considerable area, and in practically all of them tourmaline is associated with the tinstone. The "pyritic lode," which carries good values, is frequently in a brecciated condition, and the tinstone is associated with tourmaline, iron pyrites, ankerite, and sideroplesite. In some of the lodes copper minerals occur.

A memoir on *The Geology of the Waterberg Tin-fields*, published by the Geological Survey in 1909, gives much information on the tin ore deposits of this region (see this BULLETIN, 1909, **7**, 416).

NOTICES OF RECENT LITERATURE

NEW BOOKS

A HANDBOOK OF FORESTRY. By W. F. A. Hudson, M.A. Pp. 82. Crown 4to. (Watford: The Cooper Laboratory for Economic Research, 1913.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 9*d.*, abroad 2*s.* 11*d.*

The aim of this book is to provide a simple guide to the care of woodlands for the use of estate managers who may be required to deal with forestry questions in addition to their ordinary duties. The subject is a large one to be treated in eighty-two pages, and the author has confined himself to essentially practical questions, omitting all reference to matters with which an estate manager may be expected to be acquainted. A useful introduction states the chief objects of forestry, and, in answer to the question as to whether forestry "pays" in this country, quotes the financial position of the Knap Woods (Argyllshire), which appears to indicate that, under good management, an excellent profit may be obtained. The succeeding chapters deal with the topics of the forest nursery, establishment of woods, sylvicultural methods, etc., on the usual lines: the information afforded is practical and should prove useful. There is a brief discussion of "Timber," and the chapter on common forest trees deals with the characteristics of some twenty well known trees grown in this country. There is an index and a short bibliography.

Forests of British Guiana: General Report on the Forests of the easily accessible districts of the Colony. Pp. iv + 55. Detail Reports (Series I.): The Forests of the North-Western District of the County of Essequibo, Forest Districts 1–4. Pp. 26 + liv, Med. 8vo. By C. Wilgress Anderson, I.S.O., F.G.S., F.R.G.S., Forestry Officer. (Published by the Direction of His Excellency the Governor. Georgetown, Demerara: Department of Lands and Mines, 1912.)

The importance to British Guiana of a scientific survey of her forest resources needs no demonstration in face of the fact that six-sevenths of the country is classed as "forest." The two eminently practical reports under notice, based upon work commenced in 1908, afford evidence that such resources will not remain undeveloped for lack of knowledge of their extent and variety. The Crown forests of the colony are estimated to cover over 78,000 square miles, of which 11,000 are at present accessible for exploitation. The vegetation is in large measure of the rain forest type, and in the accessible region falls naturally into two divisions: (1) forests of the swamp-lands covering the flat ("marine") alluvial area inland from the coast, and (2) forests covering the slightly elevated plains and ridges towards the hinterland. Each of these divisions is capable of further classification into a fairly well defined natural series. Facility of transport is a deciding factor in the development of a timber industry, and in British Guiana at the present time river transport is alone available in the forest region. As is well known, the country is intersected by a number of fine rivers, in most cases, however, navigable only to the rapids or cataracts which interrupt their courses at varying distances from the sea. The "easily accessible" district, thus delimited, varies in depth from 35 to 110 miles inland, and embraces an area of about 17,000 square miles of country.

In the General Report the introduction reviews the topographical and geological features of the colony, and refers to the importance of geological factors in determining the composition of the forest flora. The forests are then dealt with in regard to their distribution, area, and composition, the author adopting carefully ascertained native (Arawak) names for all trees described, whether botanically identified or not. The trees are rarely of social habit, but one or more species are commonly in the majority in a forest which becomes known locally by the name of the predominant species. The chief timbers at present exported are crabwood, greenheart, wallaba, and balata-wood, while balata and Sapium rubber are also well known in commerce. These products are dealt with in short sections, affording information as to sources of supply, quantities available, and other practical information.

In the Detail Reports (Series I.) the forests of the North-West District of the County of Essequibo are dealt with. A general account of the forests is given, followed by a list of timbers with vernacular and scientific names, and specific gravity where possible. A series of appendices describes the various types of forest met with, indicating the estimated average number of trees per acre under the headings of "predominant kinds," "other common kinds," "trees in lesser numbers," and "scarcer trees." Tabular statements of the results of sectional surveys of the various types of forest are given, in which the number of trees per acre and square mile are estimated with indication of smallest, largest, and mean girths. A map showing the forest districts is included in the General Report.

De Vezelcultuur op Java en het Vezelcongres met tentoonstelling, te Soerabaia in 1911 gehouden. By Prof. Dr. G. van Iterson, jun. Verslagen en Mededeelingen van de Afdeeling Handel van het Departement van Landbouw, Nijverheid en Handel. Jaargang 1913, No. 1. Pp. vi + 240, Roy. 8vo. (Gravenhage: Afdeeling Handel.) Price 2 florins (3*s.* 4*d.*); post free, United Kingdom 3*s.* 8*d.*, abroad 3*s.* 11*d.*

Voordracht over de beteekenis van het Vezelcongres te Soerabaia voor de industrie in Nederlandsch-Indië. By Prof. G. van Iterson, jun. Verslag der Vergadering van de Nederlandsche Afdeeling der Nederlandsch-Indische Maatschappij van Nijverheid en Landbouw, gehouden op 20 Januari 1912 te 's Gravenhage, Pp. 21, Demy 8vo. (Amsterdam: J. H. de Bussy, 1912.)

The author of these works, who is Professor of Botany in the Technical University of Delft, was appointed Government delegate to the Fibre Congress and Exhibition held at Soerabaia during July and August 1911, and was instructed to make a tour of Java in order to study the position and prospects of fibre cultivation in the island. At the conclusion of this tour a report on the fibre industries of Java was prepared for the Congress and has now appeared as the former of the publications mentioned above. The fibres dealt with are those of *Agave* spp., *Musa* spp., *Hibiscus cannabinus* (Java jute), coconut fibre, kapok, ramie, cotton, and various plaiting materials, such as bamboo, rattan, "poeroen" and "mendong" (*Fimbristylis* spp.), "agel" (*Corypha Gebanga*), "pandan" (*Pandanus utilis*) and "lontar" (*Borassus flabellifer*), and various paper-making fibres. Appended to the report are (1) lists of the members of the various committees of the Congress and Exhibition, (2) statements of the conclusions arrived at by the deliberations of the Congress (see this Bulletin, 1912,

10, 301), and (3) reports on standard samples of various Java fibres. The work contains numerous excellent illustrations.

The second publication is the report of a lecture on the importance of the Soerabaia fibre congress to the industries of the Dutch East Indies, which first appeared in *De Indische Mercuur* (May 1912).

The author has also contributed an interesting and well-illustrated general article on "Vezelstoffen" (fibres) to the pages of *De Plant in Nijverheid en Handel.*

Le Celluloid et ses Succédanés. By W. Main. Pp. 163, Crown 8vo. (Paris: Gauthier-Villars.) Price 2 fr. 50; post free, United Kingdom 2*s.* 3*d.*, abroad 2*s.* 4*d.*

This work gives a general account of celluloid and its manufacture. Information is supplied with reference to the materials from which it is made, viz. cellulose nitrates and camphor, as well as of substitutes for these. No attempt has been made to render the book a complete exposition of the subject, as this would have impaired its usefulness by the inclusion of numerous patent specifications and descriptions of obsolete methods.

As celluloid has the disadvantages of being exceedingly inflammable on account of the cellulose nitrates used in its preparation and of being rather expensive owing to the camphor employed, numerous substitutes for these substances have been introduced. Special chapters are therefore devoted to viscose and viscoid, composed of cellulose xanthates, to the acetylcelluloses, and to celluloid substitutes manufactured from nitrogenous animal substances and from other materials. The properties of the various celluloids are described, and an outline is given of methods for their examination.

The mode of working celluloid is explained, and particular information is provided with regard to the manufacture of combs, umbrella handles, toys, collars and cuffs, varnishes, cinematograph films, and other articles.

The book is furnished with several illustrations of the machinery employed in this industry, and a bibliography of the subject is appended.

Technique de la Fabrication des Parfums naturels et artificiels. Par R. M. Gattefossé. Pp. 30, Demy 4to. (Paris: Office Technique de Chimie Appliquée.)

This work deals with the manufacture of both natural and synthetic perfumes.

The apparatus for the distillation of perfume-yielding plants is divided into two classes: (1) That suitable for dealing with the flowers at the place and time of their harvest, and (2) the more elaborate apparatus of the factories which deal with varied products and are continuously in operation throughout the year. In this second class is

included a detailed description of the plant employed for distillation with steam under reduced pressure.

Other sections of the work deal with the various methods of rectifying volatile oils and with the extraction of perfumes by both fixed and volatile solvents. A note on the preservation of flowers in a fresh state by refrigeration is also inserted. The increasingly important industry of synthetic perfume manufacture is treated from a general point of view.

The work is illustrated by numerous diagrams, and forms a useful summary of the technology of perfume manufacture as carried on at the present day.

The Oil-Shales of the Lothians: Memoirs of the Geological Survey, Scotland. Pp. xii + 199, Med. 8vo. Price 2*s.* 6*d.*; post free, United Kingdom 2*s.* 10*d.*, abroad 2*s.* 11*d.*

This is a second edition of a well-known and useful memoir. Part I. (94 pages), which gives an account of the geology of the oil-shale products by H. M. Cadell and J. S. Grant Wilson, has been revised by R. G. Carruthers. In Part II. (41 pages) W. Caldwell describes the methods of working the oil-shales; and in Part III. (59 pages) D. R. Steuart deals with the chemistry of the oil-shales.

The number of illustrations has been considerably increased in the new edition, and the statistics have been brought up to date. A plate has been added to illustrate the fossils occurring in the oil-shale strata, and the coloured geological map of the oil-shale fields has been revised.

The Memoir is obtainable from the usual agents for official publications of the United Kingdom.

A Manual of Petrology. By F. P. Mennell. Pp. 256, Demy 8vo. (London: Chapman & Hall, Ltd., 1913.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.* 1*d.*

This book was originally intended as a third edition of the author's *Introduction to Petrology*, but the changes made are considered to be significant enough to justify a new title. The book deals with the study of thin sections, rock-forming minerals, igneous rocks, sedimentary rocks, metamorphism, the chemistry and radioactivity of rocks, and the collection and preparation of material. The chapter dealing with crystal optics is too brief and incomplete to be of much use. The treatment of sedimentary rocks is also very incomplete, and for the sake of the student as well as of the subject, it deserves more than twelve pages in a book on petrology which gives nine pages to radioactivity. The author's demand for simplicity in rock nomenclature is commendable, but

his dislike of the well-established terms pitchstone and tachylyte is not easy to understand; and his suggestion that the terms "glassy granophyre" and "glassy dolerite" respectively should be used instead is not a good one. In accounting for the origin of igneous rocks, the author has not much respect for the theory of differentiation, and he pushes the theory of absorption, selective and otherwise, to an unnecessary extreme. The rock descriptions suffer from the author's devotion to strict limits as regards silica percentages in classification; and it seems very odd to find the statement that the well-known and typical trachyte of the Drachenfels is really a rhyolite.

Errors and misprints are scarce, but not absent. The book is clearly and interestingly written, and contains 124 illustrations. A noticeable feature of the rock descriptions is the frequent reference to colonial, and especially to South African, examples, a feature which makes the book in this respect a useful supplement to other English text-books of petrology.

History of the Basuto: Ancient and Modern. Compiled by D. Fred. Ellenberger, V.D.M., and written in English by J. C. Macgregor, Assistant Commissioner, under the auspices of the Basutoland Government. Pp. xxii + 396, Med. 8vo. (London: Caxton Publishing Company, Ltd., 1912.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 11*d.*, abroad 8*s.* 3*d.*

In a foreword we are informed that the Rev. D. F. Ellenberger—a missionary of the Paris Evangelical Mission Society—whose labours in Basutoland covered a period of forty-five years, collected and recorded the valuable information contained in this book. This information, as to the early tribal history, the wanderings and wars, and the traditions of the Basuto, was gathered direct from native sources, and in consequence has a value that will increase as time passes and traditions, under modern circumstances of government, die out. The period covered by Mr. Ellenberger's notes is from the earliest dawn of the tribal history of the Bushmen and Basuto until the year 1853, when the power of Moshesh reached its zenith. But the present volume carries events only up to the year (1833) when, with the arrival of the Paris missionaries, the modern history of the Basuto is said to begin. It is to be hoped that a supplementary volume will follow in due course, for works of this character are rare. Although ethnologists and others may disagree with some of his theories—*e.g.* the origin of the Bushmen—and be unconvinced by his daring peeps into prehistoric times, all will admit the sincerity of purpose that characterises Mr. Ellenberger's work, the laborious nature of which was enhanced by the absence of written records.

Mr. Ellenberger begins with the Deluge—that is to say, a geological period when Basutoland, as well as the plains of the Orange Free State, Bechuanaland, and the north-west of Cape Province were, it is assumed, covered by the waters of a vast inland sea draining into the Atlantic Ocean—and he builds up the country, and peoples it, with conscientious fidelity to local tradition, as well as with some regard to modern research. The ancient history of the Basuto and a detailed account of the numerous invasions that swept the country occupy the bulk of the volume. These pages are full of interesting details and valuable material for the historian of South Africa; and are followed by appendices of, perhaps, even greater value to the general reader. The compilation of the genealogical tables of the tribes dealt with in the text, which concludes the volume, must have been a very laborious task.

The researches of the author lead him to the conclusion that the Bafokeng and Barolong tribes came in from Egypt or ancient Ethiopia, during the eleventh or twelfth century; and that they are the parents of all the Bantu tribes of Central South Africa, except the Hereros and Bavenda.

The New World of the South: Australia in the Making. By W. H. Fitchett, B.A., LL.D. Pp. xiv + 402, 8vo. (London: Smith, Elder & Co., 1913.) Price 6*s.*; post free, United Kingdom 6*s.* 4*d.*, abroad 6*s.* 7*d.*

Dr. Fitchett writes attractively on the early days of Australia, carrying his story up to Mitchell's third expedition, in 1836—with a brief allusion to his fourth, in 1845, when "Australia Felix" was revealed to the world. He might easily have included the explorations of Eyre in 1840 and the introduction of responsible government in 1855. But this is essentially a popular work, in which picturesque aspects of the opening up of the island-continent are dwelt upon, to the exclusion of more prosaic factors of political settlement.

Although, perhaps, not an unprejudiced historian, we have no fault to find with his judgment on the evidence brought forward in this book. The capricious and baffling hydrography of Australia is dealt with, in considerable detail, in a manner that will satisfy geographers who do not hold divergent views.

The sea stories in Book I. lay some geographical ghosts and make Captain Cook—with some appearance of justice—the true "discoverer" of Australia. Separate chapters deal with Cook and his work, the mapping of the Australian coast-line, early sea disasters, and the adventurous journeys of Flinders and Bass. Book II. is devoted to tales of the early days: the rule of the whip and convict settlement, the strange story of Governor Bligh, and the

fine achievements of the man who deposed him (Major Johnston), the clash of White and Black. Early exploration is ably handled in Book III.; and Book IV. concludes with a narration of stirring adventures by noted bushrangers, pirates, and outlaws.

Dr. Fitchett has given us a narrative of sustained and engrossing interest, which, whilst making a wide appeal, is of special interest to geographical readers.

LIPPINCOTT'S NEW GAZETTEER: A Complete Pronouncing Gazetteer and Geographical Dictionary of the World. Edited by A. and L. Heilprin. Pp. x + 2105, Imp. 8vo. (London: J. B. Lippincott Co., 1912.) Price £2 2*s.* net; post free, United Kingdom, £2 2*s.* 9*d.*

The last edition of this well-known Gazetteer of the World was issued in 1906, when a notice of it appeared in this BULLETIN (1906, **4**, 267). The present issue is a reprint of the last, to which has been added a conspectus of the thirteenth census of the United States, giving the area and population of the states and counties and the population of the incorporated cities, towns, boroughs, etc., in 1910. As the information in the bulk of the work is only brought down to 1905, much of it is naturally somewhat out of date, but the book will still serve a useful purpose in providing a mass of detailed information relating to the world as a whole and to the American continent in particular.

THE GUIDE TO SOUTH AND EAST AFRICA. Edited annually, by A. Samler Brown and G. Gordon Brown, for the Union-Castle Mail Steamship Company, Ltd., 1913 Edition. Pp. liv + 695, Crown 8vo. (London: Sampson Low, Marston & Co., Ltd.) Price 1*s.* net; post free, United Kingdom 1*s.* 4*d.*, abroad 1*s.* 8*d.*

This well-known handbook, designed for the use of tourists, sportsmen, invalids, and settlers, has been considerably enlarged and improved by the addition of new matter and maps relating to East Africa. The book, formerly devoted chiefly to South Africa, is now divided into two parts, the first dealing with the Union of South Africa, Rhodesia, Portuguese West Africa, and German South West Africa, and the second part with British, German, and Portuguese East Africa, Uganda, and Nyasaland. The arrangement of the subject matter is similar to that of previous editions.

LESSONS ON ELEMENTARY HYGIENE AND SANITATION. By W. T. Prout, C.M.G., M.B., C.M. 3rd Edition. Pp. xx + 184, Demy 8vo. (London: J. & A. Churchill, 1913.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 9*d.*, abroad 2*s.* 10*d.*

This is a very readable, popular account of the elemen-

tary principles on which the preservation of health depends, with special reference to tropical countries. The subject is a wide one, and the treatment is necessarily somewhat superficial, but the book will serve a good purpose if it creates a greater general interest in this very important subject. It would, however, possess still greater value if it provided fuller and more precise directions for carrying out the sanitary precautions recommended. A serious defect is the absence of an index, especially as the table of contents, though fairly full, has unfortunately no references to the pages where the topics referred to are dealt with.

"VERB. SAP." ON GOING TO WEST AFRICA, NORTHERN NIGERIA, SOUTHERN NIGERIA, AND TO THE COASTS. By Captain Alan Field, F.R.G.S., 3rd Edition. Pp. 251, Crown 8vo. (London: Bale, Sons & Danielsson, Ltd., 1913.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 10*d.*, abroad 2*s.* 11*d.*

The new edition of this book follows the general lines of the previous editions (see this BULLETIN, 1905, **3**, 385) and will serve a useful purpose as a guide to those about to visit the West Coast of Africa; the "official informative article on the Congo Free State" referred to in the preface appears to have been inadvertently omitted in compiling the book.

WELTADRESSBUCH DER CHEMISCHEN INDUSTRIE. Pp. 1053, Med. 8vo. (Berlin: Verlag der Union Deutsche Verlagsgesellschaft, 1913.)

This is an international directory of firms and persons connected in any way with chemical industry. It includes the names of producers, exporters, and dealers concerned with either, the raw materials which form the basis of pharmaceutical and chemical manufactures, or the finished products of such factories. Names of makers of laboratory apparatus, and of machines and plant for factories are also included, as well as a list of patent agents. There can be no question that the publishers have performed a very useful service to chemical industry in compiling this directory.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

THE QUALITY OF PARA RUBBER FROM VARIOUS SOURCES

In the following pages an account is given of the results of the examination at the Imperial Institute of a number of samples of Para rubber from Ceylon, India, Southern Nigeria, British Guiana, and Papua.

Ceylon

In previous numbers of this Bulletin (1911, **9**, 300, 406; 1912, **10**, 496) reference has been made to tapping experiments carried out in Ceylon with the object of ascertaining the most suitable interval between successive tappings. Seven samples of the rubber obtained in the course of these experiments were received at the Imperial Institute for examination. Each sample consisted of a number of biscuits and represented the rubber prepared from a row of trees tapped at intervals of one, two, three, up to seven days respectively.

The samples exhibited good physical properties on the whole, but a few of the biscuits were rather weak. The results of the chemical analyses are shown in the following table:

Percentage Composition of Dry Washed Rubber

	Caoutchouc.	Resin.	Protein.	Ash.
No. 1	95·7	1·7	2·3	0·3
No. 2	95·4	2·5	1·9	0·2
No. 3	96·1	1·7	2·0	0·2
No. 4	96·3	1·8	1·7	0·2
No. 5	96·0	2·0	1·8	0·2
No. 6	96·3	2·0	1·5	0·2
No. 7	96·3	1·8	1·7	0·2

It will be seen that all the samples were of very good quality, so far as composition is concerned, and it is of interest that the rubber obtained by tapping at intervals of three to seven days contained a little more caoutchouc than the rubber obtained by tapping every day or every other day.

For an account of other samples of Para rubber produced in the course of tapping experiments in Ceylon, see this BULLETIN (1912, **10**, 380).

INDIA

Six samples of Para rubber produced in the Mergui District, Burma, were received for examination in July 1912. The samples were as follows :

No. 1. "*Scrap Crêpe.*"—Thick crêpe rubber of dark brown colour, well prepared, and containing only a small quantity of vegetable impurity. The physical properties of the rubber were very good.

No. 2. "*Dark Crêpe.*"—Rather thick crêpe rubber, very similar to the preceding specimen, but a little darker and not quite so clean. The physical properties of the rubber were very good.

No. 3. "*Smoked Crêpe No.* 1."—Thin reddish-brown crêpe rubber, possessing a distinct smoky odour. The rubber was clean and well prepared, and its physical properties were satisfactory.

No. 4. "*Smoked Crêpe No.* 2."—Thin crêpe rubber varying in colour from light to dark brown and having a smoky odour. The rubber was fairly clean, and its physical properties were satisfactory.

No. 5. "*Pale Crêpe.*"—Thin pale crêpe rubber, clean and

well prepared. The rubber exhibited very good physical properties.

No. 6. "*Crêpe.*"—Thin pale crêpe rubber, clean and well prepared, but rather darker than the preceding specimen of "pale crêpe."

The results of chemical analyses and the valuations of the samples are shown in the following table:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Loss on washing (moisture and impurities)	0·8	1·6	0·4	0·4	nil.	0·2
Composition of dry washed rubber:						
Caoutchouc	92·1	92·0	92·8	90·0	94·3	93·6
Resin	2·8	2·5	3·6	3·1	3·2	3·1
Protein	3·3	3·8	3·1	2·9	2·2	3·0
Ash	1·8	1·7	0·5	4·0	0·3	0·3
Value in London, with fine hard Para at 3*s.* 4*d.* per lb.	3*s.* 2*d.*	3*s.* 2*d.*	3*s.* 3*d.*	3*s.* 3*d.*	3*s.* 4*d.*	3*s.* 3½*d.*

It will be seen that the samples showed some variation in composition. In general the percentages of resin and protein were a little higher than is usual in the best plantation Para, and in three cases, viz. Nos. 1, 2, and 4, the amount of ash was excessive. The two best specimens, Nos. 5 and 6, contained 94·3 and 93·6 per cent. of caoutchouc respectively in the dry material, and were of very good quality.

Southern Nigeria

Two samples of Para rubber grown at Sapele, Central Province, Southern Nigeria, were received in May 1912 and January 1913 respectively. Previous samples obtained during tapping experiments at Ebute Metta and at Orugbo were dealt with in this Bulletin (1910, **8**, 342).

No. 1.—This consisted of two rough biscuits of dark brown rubber with a strong smoky odour. The rubber was clean and well prepared, but contained some specks of solid impurity; the physical properties of the rubber were satisfactory.

No. 2.—This sample consisted of a large thin biscuit of brown rubber, which was very well prepared, although a

little rough on the surfaces. The rubber, which had been slightly smoked, exhibited excellent physical properties.

The results of the chemical examination of the two samples were as follows:

	No. 1. Per cent.	No. 2. Per cent.
Loss on washing (moisture and impurities)	0·6	0·6
Composition of dry washed rubber:		
Caoutchouc	93·0	93·8
Resin	4·3	3·5
Protein	2·2	2·3
Ash	0·5	0·4

Sample No. 1 was classed as fair average quality by brokers, and was valued at about 4*s.* 10*d.* per lb. in London, with fine hard Para at 4*s.* 10½*d.* per lb., and smoked plantation sheet at 4*s.* 8*d.* to 4*s.* 11*d.* per lb. Sample No. 2 would have a similar value.

The results of the examination show that these rubbers were satisfactory both in composition and physical properties, and that consignments of similar character would realise very good prices in the market.

British Guiana

A sample of Para rubber biscuits and one of scrap rubber were received from British Guiana in February of this year. The rubber was obtained from trees planted at the Government Rubber Station at Issorora in the North-West District of the Colony. The trees were first tapped in July 1912, when they were about four and a half years old, their average girth at 3 ft. from the ground being 18 in.; tapping was continued every second day for six months. The samples of rubber were as follows:

No. 1. *Biscuit Rubber.*—Small thin biscuits, light brown to reddish-brown in colour, clean and in good condition. The rubber was slightly weak, but, considering the age of the trees from which it was obtained, its physical properties must be regarded as quite satisfactory.

No. 2. *Scrap Rubber.*—Cakes of rubber varying in colour from light brown to almost black. Like the preceding specimen, the rubber was slightly weak.

The results of examination of the samples are shown in the following table:

	Biscuit rubber.	Scrap rubber.
	Per cent.	*Per cent.*
Loss on washing (moisture and impurities).	1·0	2·8
Composition of dry washed rubber:		
Caoutchouc	95·3	93·7
Resin	2·0	2·5
Protein	2·5	3·2
Ash	0·2	0·6

The biscuit rubber was valued at about 3*s.* per lb. in London and the scrap rubber at about 2*s.* 6*d.* per lb., with fair average-quality plantation sheets and biscuits at 3*s.* 1½*d.* to 3*s.* 2½*d.* per lb., and fine hard Para at 3*s.* 6½*d.* per lb.

The biscuit rubber was very satisfactory in chemical composition, containing over 95 per cent. of caoutchouc in the dry material, and in this respect it was quite equal to plantation Para rubber from the East. The strength of the rubber will no doubt improve as the trees become older, and the product will then be of excellent quality. The scrap rubber was also of good quality. It contained a little more resin, protein, and ash than the biscuit rubber, and consequently the percentage of caoutchouc was lower.

PAPUA

Up to the present all the rubber exported from Papua has been obtained from *Ficus Rigo* and an unidentified vine, which are indigenous to the island (cf. this BULLETIN, 1912, **10**, 386), but *Hevea brasiliensis* and other rubber-yielding trees have been planted, the area under the former on March 31, 1912, being 4,496 acres. Some of the Para rubber trees are now coming into bearing, and tapping has been commenced recently. A sample of the first consignment of Para rubber produced in the Territory was received at the Imperial Institute for examination in November 1912. It was stated to have been obtained from trees grown at Sogeri, 32 miles from Port Moresby, at an elevation of about 1,200 ft., and about 25 miles from the coast.

The rubber was in the form of large thin sheets of pale brown colour; it was clean and very well prepared. The

physical properties of the rubber were excellent. It was analysed with the following results:

	Per cent.
Loss on washing (moisture and impurities)	0·4
Composition of dry washed rubber:	
Caoutchouc	95·7
Resin	2·8
Protein	1·3
Ash	0·2

The sample was valued at 4*s*. per lb. in London with fine hard Para at 3*s*. 11*d*. per lb. and fair average-quality plantation sheets and biscuits at 3*s*. 10¾*d*. to 3*s*. 11¼*d*. per lb.

This rubber from Papua was of excellent quality both as regards chemical composition and physical properties. In these respects it was quite equal to the best plantation rubber produced in the East, and consignments of similar character would always realise the current market price of the highest grades of plantation rubber. The prospects of the cultivation of the Para tree in Papua, therefore, appear to be exceedingly promising.

CEARA RUBBER FROM NORTHERN NIGERIA

The Ceara rubber which is dealt with below was received from Northern Nigeria in January of this year. The following particulars in regard to the rubber were supplied by the Director of Agriculture.

The sample consisted of balls and strips of rubber and represented the produce of nine trees, which were said to be six years old, their average girth being 18 in. The trees were growing at Bida, and their poor growth may probably be accounted for by the poverty of the soil at that place. Tapping took place in the morning between 6.0 a.m. and 7.0 a.m. every alternate day, on the Lewa system as practised in East Africa, the latex being coagulated on the tree with fresh lime juice. The total number of tappings was fourteen, but the yield of rubber diminished very rapidly after the fourth tapping. This experiment was carried out towards the end of the rains, and probably a great deal more rubber could have been obtained if the trees had been tapped

earlier in the season. The trees did not appear to have been seriously damaged by the tapping.

The strips of rubber were light brown, clean, and well prepared, and very satisfactory in physical properties. The balls were darker in colour and not of such good appearance as the strips, owing to the development of mould on the surface.

For the purpose of chemical examination the strips of rubber were taken and were found to have the following composition:

	Per cent.
Loss on washing (moisture and impurities)	8·6
Composition of dry washed rubber:	
Caoutchouc	82·3
Resin	7·6
Protein	8·4
Ash	1·7

The rubber was therefore of very fair quality, comparing favourably in composition with specimens of Ceara rubber prepared in East Africa by the Lewa process. Ceara rubber obtained by this method usually contains a rather high percentage of protein, as the whole of the protein present in the latex is included in the rubber.

Ceara rubber in strips or balls similar to these samples would always be readily saleable. The rubber in strips would be more valuable than that collected in balls, and as the preparation of the strips involves no difficulty the collection of the rubber in this form should be encouraged. It is impossible to give a definite valuation for such a small sample, but rubber in strips similar to the sample would probably be worth about 3*s.* 6*d.* per lb. in London with fine hard Para at 3*s.* 11*d.* per lb., whilst the balls would probably realise a few pence per lb. less, say 3*s.* 3*d.* to 3*s.* 4*d.* per lb.

THE COTTON INDUSTRY OF UGANDA

The development of the cotton industry of Uganda dates from 1904, when the Government imported seed of three varieties of Egyptian cotton. Shortly afterwards the

Uganda Company introduced American Upland, Peruvian, Sea Island, and other cottons. As there was no organisation for dealing with the industry at that time, the seed became mixed, and for several years the lint produced was a mixture of the different varieties which had been introduced, and in which American Upland characteristics largely predominated. The staple was naturally very irregular, and spinners were unable to deal with the product economically. In 1908 an Ordinance was enacted which gave the Government power to make rules for maintaining and improving the quality of the cotton produced in the Protectorate (see this BULLETIN, 1909, **7**, 92). Rules were made which prohibited the sowing of any seed other than that provided by Government. The variety supplied by Government was an American Upland cotton, "Black Rattler," and during 1908 and 1909 all plants exhibiting Egyptian characteristics were uprooted as far as possible in order to keep the newly introduced variety as pure as possible. Although this action resulted in a more uniform type of cotton being produced in the Protectorate, the quality was still capable of improvement, and the production of an acclimatised cotton of good quality has formed an important part of the experimental work carried out under Government supervision during recent years. An account of this work was included in an article by Mr. P. H. Lamb, lately chief Agricultural Officer in Uganda, published in this BULLETIN last year (1912, **8**, 424), to which reference should be made for fuller details.

Since the Government took the work in hand the cotton industry has made rapid progress. In 1903–4 the value of the cotton exported amounted to only £6, in 1906–7 the exports had risen to £11,411, and in 1911–12 to £230,850. Much of the cotton is ginned in the country, five factories being in operation on March 31, 1912, whilst the total number of gins in the country on that date was 74 roller gins, 5 saw gins, and 82 hand gins. The unginned cotton exported from Uganda is ginned at Kisumu, on the East Africa Protectorate side of Victoria Nyanza.

The quantities and values of ginned and unginned cotton exported from Uganda in recent years are shown in the following table :

	1908–9.		1909–10.		1910–11.		1911–12.	
	cwt.	£	cwt.	£	cwt.	£	cwt.	£
Ginned .	10,247	30,003	13,197	27,416	32,694	120,664	59,227	184,639
Unginned .	12,806	11,229	29,922	22,180	50,281	44,748	45,664	46,211

Cotton seed is also exported in considerable quantity, the exports in 1911–12 being 58,549 cwt., valued at £5,909. An oil-extraction plant capable of producing 192 gallons of cotton seed oil and 4 tons of cake per day of 8 hours has been erected.

The estimated area under cotton in the various districts of Uganda in 1911–12 was as follows:

District.	Area. *Acres.*	District.	Area. *Acres.*
Buganda . .	27,380	Bunyoro . .	3,700
Bukedi . .	19,720	Toro . . .	120
Busoga . .	10,000	Ankole . .	100

Transport difficulties offer a serious hindrance to the extension of cotton growing in many parts of the Protectorate, but the completion of the Busoga railway from Jinja to Kakindu should prove of great value to the neighbouring district, whilst a portion of the loan of £500,000 provided by the British Government for the development of the cotton industry is to be expended on the construction of roads in various parts of the Protectorate.

A large number of samples of Uganda cotton have been examined at the Imperial Institute. Samples of "Sunflower," "Allen's Improved," and "Abassi" cotton have already been described in this BULLETIN (1912, **10**, 481), and other samples have been dealt with in *British Cotton Cultivation. Reports on the Quality of Cotton grown in British Possessions* (*Colonial Reports, Miscellaneous Series*, No. 50 [Cd. 3997], 1908, p. 15). In the following pages the results of examination of samples received in recent years are given.

No. 1. *Black Rattler.*—This sample of ginned cotton, grown in the Chiope District, was received in February 1907. It consisted of rather harsh and woolly, fairly lustrous cotton of very even cream colour and free from stains.

The strength of the fibres was normal, and they varied in length from 1·2 to 1·5 in.; their diameter ranged from 0·0005 to 0·0012 in., with an average of 0·0008 in.

This cotton was of excellent quality, and would be readily saleable. The sample was valued at about 8*d.* per lb. with "middling" American at 7·40*d.* per lb.

The following twenty samples of seed-cotton were received in September 1908. They were procured from various districts of the Protectorate, and each sample represents an individual load as brought to the ginneries by the native growers. They consequently convey an accurate idea of the general character of the cotton produced in the country at that time. The seed from which the samples were obtained was the product of the early importations of Egyptian and American Upland varieties, and was specially selected with the object of eradicating the former type owing to its alleged unsuitability to the country. The cotton was therefore produced from acclimatised seed, the youngest of which was seed in its second season, and the oldest in its fifth season.

No. 2. From Bulemezi District.—The yield of lint on ginning was 33 per cent. The lint was soft, lustrous, pale cream in colour, with a slight reddish tinge, and some brown and yellow stains. The seeds of this sample, as well as of samples 3 to 21, were of average size, and generally closely covered with a light brown down. The present sample contained also a small proportion of smooth seeds. Twenty per cent. of the seeds examined were withered, but no insect pests were noticed either in the cotton or in the seed.

The strength of the cotton was normal; the length varied from 1·1 to 1·5 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·0007 in.

Compared with a standard sample of Upland cotton, this cotton was longer and deeper in colour. In its other characters it resembled the American cotton, and would probably be classed as a fairly high grade of this variety. It was valued at 5·60*d.* per lb., ginned, with "middling" American at 5·17*d.* per lb.

No. 3. From Bulemezi District.—The lint obtained on

ginning this sample was similar to that of No. 2, but the yield was 32 per cent. The seed also resembled that of No. 2, but a slightly larger proportion of smooth seeds was present. Twenty per cent. of those examined were withered.

The cotton was of uneven strength, some portions being very weak. The fibres varied in length from 1·1 to 1·4 in., and their diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00073 in.

The lint in this case was valued at 5·50*d.* per lb.

No. 4. From Bulemezi District.—Both lint and seed were similar to those of No. 2. The yield of lint on ginning was 34 per cent., whilst 36 per cent. of the seeds examined were withered.

The cotton was of normal strength on the whole, but some portions were rather weak. It varied in length from 1·0 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00075 in.

The ginned cotton was valued at 5·60*d.* to 5·70*d.* per lb.

No. 5. From Bulemezi District.—The lint in this case also was similar to that of No. 2, but was more even in colour; the yield on ginning was 32 per cent. Twenty-six per cent. of the seeds examined were withered.

The cotton was of normal strength; the length varied from 1·1 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·0007 in.

This sample was similar to the preceding one, but was rather more even in colour. It was valued at 5·70*d.* to 5·80*d.* per lb. ginned.

No. 6. From Bulemezi District.—This sample yielded on ginning 32 per cent. of soft, lustrous lint, which was pale cream in colour, with occasional brown and yellow stains. The seeds were similar to those of No. 2, but about two-thirds were smooth. Twenty per cent. of those examined were withered.

The strength and length of this cotton were similar to those of No. 5. The diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00072 in.

This cotton was of fair quality, but rather stained. It was valued at 5·50*d.* per lb., ginned.

No. 7. From Gomba District.—This sample yielded on ginning 31 per cent. of lint of similar appearance to that of No. 2. In this case, however, there was a slightly larger proportion of smooth seeds. Thirty per cent. of the seeds examined were withered, but no insect pests were noticed.

This cotton was of uneven strength, some portions being rather weak. The length varied from 1·1 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00068 in.

This cotton appeared to have been grown from the same type of seed as No. 2, from Bulemezi District. Although somewhat inferior in strength, it was of similar quality, and was valued at the same price.

No. 8. From Gomba District.—This sample also yielded 31 per cent. of soft lustrous lint on ginning, but the lint was very uneven in colour and contained an unusually large quantity of yellowish-brown stained cotton. About 30 per cent. of the seeds examined were withered, and there were signs of the attack of insect pests.

This cotton was of poor strength; the length of the fibres varied from 1·0 to 1·4 in., and their diameter ranged from 0·0004 to 0·0010 in., with an average of 0·0007 in.

This cotton was of rather poor quality, and much stained. It was valued at 5·30*d.* per lb., ginned. Several small, reddish grubs were noticed in the sample. These were dry and generally mutilated, but they bore a strong resemblance to insects of *Gelechia* sp. (see this BULLETIN, 1913, **11**, 354).

No. 9. From Gomba District.—This yielded 31 per cent. of lint on ginning. The lint was soft, lustrous, pale cream in colour, but much stained. Forty per cent. of the seeds examined were withered; there were signs of the attack of insect pests, but no specimens were noticed.

The strength of the cotton was uneven, some portions being very weak. The length and diameter of the fibres were the same as in No. 8.

This cotton also was of rather poor quality and much stained, and was valued at 5·30*d.* to 5·35*d.* per lb., ginned.

No. 10. From Gomba District.—This yielded on ginning 33 per cent. of soft, lustrous lint of pale cream colour, and

generally free from stains. Forty per cent. of the seeds examined were withered.

The cotton was of normal strength. The length varied from 1·1 to 1·4 in., and the diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00068 in.

This sample was of good quality, clean and lustrous, and was valued at 5·80*d.* per lb., ginned.

No. 11. From Gomba District.—The yield and appearance of the lint of this sample were the same as those of No. 10, except that a quantity of yellowish-brown stains was present. Thirty per cent. of the seeds examined were withered.

The strength of the cotton was uneven, some portions being rather weak. The cotton varied in length from 1·0 to 1·4 in., and in diameter from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This cotton was of fairly good quality, but rather stained. It was valued at 5·60*d.* per lb., ginned.

No. 12. From Bunyoro District.—The lint in this case resembled that of No. 2 in appearance; the yield on ginning was 33·5 per cent. Smooth and "woolly" seeds were present in about equal proportions, whilst 20 per cent. of those examined were withered.

The cotton was of uneven strength, some portions being rather weak. It varied from 1·0 to 1·4 in. in length, and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00071 in.

The ginned cotton was valued at 5·60*d.* per lb.

No. 13. From Bunyoro District.—This yielded on ginning 31 per cent. of soft, lustrous lint of even pale cream colour, and almost free from stains. About 20 per cent. of the seeds were smooth; all those examined were healthy, and there were no signs of the attack of insect pests.

The cotton was of normal strength. The length varied from 1·0 to 1·3 in., and the diameter ranged from 0·0005 to to 0·0011 in., with an average of 0·00072 in.

This cotton was of very good quality, and was valued at 5·90*d.* per lb., ginned.

No. 14. From Busiro District.—The lint of this sample was similar to that of No. 2, but was more even in colour;

the yield on ginning was 32 per cent. Smooth and "woolly" seeds were present in about equal proportions. Twenty-four per cent. of those examined were withered.

The cotton was of normal strength on the whole; the length varied from 1·0 to 1·4 in., and the diameter ranged from 0·0004 to 0·0010 in., with an average of 0·00071 in.

This sample was similar to Nos. 2–6, but of better colour, and was valued at 5·90*d.* per lb., ginned.

No. 15. From Busiro District.—This yielded on ginning 32 per cent. of soft, lustrous lint of pale cream colour, with some brown and yellow stains. Thirty-five per cent. of the seeds examined were withered.

The strength of the cotton was rather uneven, some portions being weak. The fibres varied in length from 1·0 to 1·4 in., and in diameter from 0·0004 to 0·0010 in., with an average of 0·00069 in.

This cotton was of fair quality, but somewhat stained. It was valued at 5·40*d.* per lb., ginned.

No. 16. From Busiro District.—The lint of this sample was similar to that of No. 15, but was of rather deep cream colour, with a small quantity of reddish-brown stains; the yield on ginning was 33 per cent. About 30 per cent. of the seeds examined were withered.

The cotton was of normal strength on the whole, but some portions were rather weak. The length varied from 1·0 to 1·4 in., and the diameter ranged from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This sample was of fair quality, but rather poor in colour. It was valued at 5·40*d.* to 5·50*d.* per lb., ginned.

No. 17. From Busiro District.—This seed-cotton yielded on ginning 32 per cent. of soft, lustrous lint of even pale cream colour and generally free from stains. Eighteen per cent. of the seeds examined were withered.

The strength of this cotton was normal, whilst the length and diameter of the fibres were the same as in No. 16.

The cotton was of good quality, clean and lustrous, and was valued at 5·80*d.* per lb., ginned. Some insects of *Oxycarenus* sp. were noticed in the cotton, but they did not appear to have damaged it in any way.

No. 18. From Singo District.—The lint in this case was fairly soft, lustrous, of deep cream colour, with some slight brown stains; the yield on ginning was 32 per cent. About 25 per cent. of smooth seeds were present, whilst 25 per cent. of those examined were withered.

This cotton was of normal strength but uneven in length, the fibres varying from 0·9 to 1·4 in. Their diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00074 in.

This sample was rather stained, but of much better colour than many of the preceding samples. It was valued at 5·70*d.* per lb., ginned.

No. 19. From Singo District.—This sample yielded on ginning 31 per cent. of lint, which was soft, lustrous, and of pale cream colour, with occasional reddish-brown stains. About one-third of the seeds were smooth, whilst 25 per cent. of those examined were withered.

The strength of the cotton was normal on the whole, but some portions were rather weak. The length varied from 1·1 to 1·4 in., and the diameter from 0·0004 to 0·0010 in., with an average of 0·00075 in. This cotton was of fairly good quality, and was valued at 5·60*d.* to 5·70*d.* per lb., ginned.

No. 20. From Mawokota District.—The lint obtained on ginning this sample was soft and lustrous, of even pale cream colour, and generally free from stains; the yield was 33 per cent. Twenty per cent. of the seeds examined were withered.

This cotton was of normal strength, and the fibres varied from 1·0 to 1·4 in. in length and from 0·0005 to 0·0010 in. in diameter, with an average of 0·00073 in.

This sample was clean and lustrous, and of very good quality. It was valued at 5·90*d.* to 6·00*d.* per lb., ginned.

No. 21. From Mawokota District.—This sample yielded 31·5 per cent. of soft, lustrous lint of rather deep cream colour, with a quantity of reddish-brown stains. Forty per cent. of the seeds examined were withered.

The strength of this cotton was generally normal. The length varied from 1·2 to 1·5 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·00071 in.

This cotton was of fairly good quality, but was rather stained. It was valued at 5·50*d.* per lb., ginned.

All these samples of cotton (Nos. 2–21) were of very promising quality, and would be readily saleable. Generally speaking, they showed a decided improvement on specimens of similar type from Uganda, previously examined at the Imperial Institute.

The cottons were considerably softer, and had a greater length of staple, than a standard sample of American Texas cotton with which they were compared. In all cases the valuations given were higher than that of "middling" American cotton on the same date, viz. 5·17*d.* per lb.; but long-stapled cotton of the type represented by these samples is nominally worth about 1*d.* or 2*d.* per lb. more than "middling" American cotton, so that in most cases the present samples were of lower value than standard samples of the same type.

No. 22. *Black Rattler.*—This sample of seed-cotton, grown at the Buddu cotton-seed farm, was received in January 1909. The yield of lint on ginning was 38 per cent., the yield per 100 seeds being 5·63 grams. The lint was fairly soft, lustrous, of even pale cream colour, and generally free from stains. The seeds were of medium size; two types were present in about equal proportions: (*a*) smooth, dark brown seeds with slight tufts at the pointed ends; (*b*) seeds closely covered with a short light-brown down. Ten per cent. of those examined were withered.

The cotton was of fairly good strength, but some portions were rather weak. The length varied from 0·8 to 1·2 in., with an average of 1·0 in., and the diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00078 in.

Two valuations of this cotton were obtained: (1) possibly 4¾*d.* per lb., ginned, with "middling" American at 5·13*d.* per lb.; (2) about 5½*d.* per lb., ginned, with "middling" American at 5·52*d.* per lb.

If this cotton was grown from true "Black Rattler" seed, it would appear that the seed may have been of inferior quality, since, although the cotton was of very good appearance and free from stains, it was considerably shorter than previous samples of cotton of the same variety, which were found on the average to vary in length

from 1·1 to 1·4 in. The present sample, averaging only 1·0 in. in length, was barely equal in this respect to ordinary "middling" American cotton, and was decidedly inferior to the more valuable varieties of "improved" American, such as are represented by a normal sample of "Black Rattler" cotton. The shortness of staple in the present instance seriously lowered the value.

No. 23. *Black Rattler.*—A sample of seed-cotton and one of ginned cotton of this variety, which were stated to be the first year's produce of newly imported seed, were received in June 1909. The seed-cotton yielded on ginning 37 per cent. of lint, the yield per 100 seeds being 5·9 grams. The lint was soft, very lustrous, of an even pale cream colour, and entirely free from stains. The seeds were of medium size; about 60 per cent. were closely covered with a very short, light brown down, whilst the remainder were smooth, dark brown in colour, and bore light brown tufts at the pointed ends. The seeds were generally very healthy, only 6 per cent. of those examined being withered.

The cotton was of normal strength on the whole. The length of the fibres varied from 0·9 to 1·2 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00073 in.

Although of short staple, this cotton was of very good quality, and would be readily saleable in the English market. It was probably worth about 6½*d.* per lb., ginned, with "middling" American at 6·56*d.* per lb. The average length of "Black Rattler" cotton (1·2 to 1·5 in.) is, however, greater than that of the present sample, and on this account a well-grown sample of the "Black Rattler" variety should have a considerably higher value than ordinary Upland cotton.

This cotton was very similar to No. 22 (*see above*); both samples were of approximately the same value when considered in relation to that of "middling" American.

No. 24. *Black Rattler.*—Further samples of seed-cotton and ginned cotton from newly imported seed, first year's sowing, were received in July 1909.

These were of very similar quality to the preceding two

samples. The only differences observable were (1) an apparently higher percentage of lint (40 per cent.), and (2) a slightly greater average diameter of fibres (0·0008 in.). The former difference is to be attributed to the presence in this sample of a larger proportion of withered seeds, which are lighter than healthy seeds, whilst the increased average diameter of the fibres is probably to be accounted for by the presence of a small quantity of slightly immature fibres, which are generally of greater diameter than fully mature fibres. There were no signs of the attack of insect pests, but about 40 per cent. of the seeds examined had been attacked probably by a fungoid pest, and would be useless for sowing. In all other respects the cotton resembled No. 23, and would probably have the same market value.

No. 25.—A specimen of cotton, which was stated to be a sample of the new Uganda crop, was received in June 1909. It consisted of clean ginned cotton, soft, lustrous, and of even pale cream colour, with occasional yellow stains. The strength was uneven, some portions of the cotton being very weak. The length of the fibres was 1·0 to 1·3 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

The cotton was of very good marketable quality, but its slightly stained condition somewhat depreciated the value. It resembled Nos. 22–24 (*see above*) in being of rather shorter staple than some previous samples of the Black Rattler variety grown in the Protectorate. The sample of the new crop was very slightly longer, and perhaps a little more silky than Nos. 22–24, but it was distinctly inferior to them in appearance.

No. 26.—A sample of ginned cotton, stated to be the "best yet grown in the country," was received in November 1909. It consisted of clean, soft, lustrous cotton, of fairly even cream colour, with some slight yellowish-brown stains.

The strength was normal on the whole, but the stained portions were rather weak. The length varied from 1·0 to 1·4 in., and the diameter ranged from 0·0006 to 0·0011 in., with an average of 0·0008 in.

This cotton was valued at about 8·62*d.* per lb., with "middling" American at 7·62*d.* per lb., and although of good length, its value was considerably reduced on account of its somewhat unsatisfactory colour. The slight stains noticed in the sample suggested that the crop had been attacked to some extent by insect pests. The value of the material would have been enhanced if the stained portions had been completely removed before the product was ginned.

No. 27. *Kampala Cotton.*—This sample of ginned cotton was received in July 1910. It consisted of fairly harsh, lustrous cotton, of cream colour with some brown and pale yellow stains. It was of normal strength on the whole, but some parts were weak. The length of the fibres varied from 0·8 to 1·3 in., but was mostly from 1·0 to 1·2 in. The diameter ranged from 0·0006 to 0·0011 in., with an average of 0·00081 in.

This sample was regarded as being fairly representative of the bulk of the Uganda crop derived from the acclimatised plant. Its quality was very satisfactory, and it was valued at 70 to 80 points (0·7*d.* to 0·8*d.*) on "middling" American, but the value would be still higher if the cotton could be obtained free from stains.

No. 28. *Buddu Cotton.*—This was received with the preceding sample, and consisted of rather harsh, fairly lustrous cotton of deep cream colour, with some brown and pale yellow stains. The cotton was rather weak, and somewhat irregular in length, varying from 0·7 to 1·4 in., but was mostly from 0·9 to 1·2 in. The diameter ranged from 0·0006 to 0·0011 in., with an average of 0·00083 in.

The value of this cotton was only 10 to 20 points (0·1*d.* to 0·2*d.*) on "middling" American. The fact that it was of poorer quality and lower value than the sample of "Kampala cotton" (No. 27) is of considerable interest, since it appears from the Report of the Uganda Cotton Department for 1909–10 that the seed from which the "Buddu cotton" was grown was the offspring of the imported "Black Rattler" variety. The "Kampala cotton," on the other hand, is believed to have been derived from the acclimatised Uganda cotton, and the results of the

present examination afford further evidence that this cotton is superior to the "Black Rattler" variety.

A series of five samples of cotton (Nos. 29 to 33) was received in October 1910. These consisted of (1) a typical sample of the ordinary seed-cotton of Bukedi; (2) the same as (1), but hand-picked to remove stained and immature cotton, as is done prior to ginning in the case of seed for distribution, and subsequently passed through a cleaning machine; (3) the same as (2), but roller-ginned; (4) a typical sample of seed-cotton from Buddu, where climate and other conditions militate against quality; (5) the same as (4) but roller-ginned. Samples (1) and (2) were forwarded with the object of ascertaining what difference exists in the commercial value of seed-cotton as often presented by the native for sale, and the same article after dirty and stained cotton has been removed by hand-picking. The samples were examined with the following results. At the date of valuation of the samples "middling" American cotton was quoted at 8·05*d.* per lb.

No. 29. *Bukedi Ordinary.*—This yielded on ginning 33·7 per cent. of lint, the yield per 100 seeds being 4·6 grams. The lint was soft, lustrous, and of pale cream colour, but not very clean and showing some yellow stains. The seeds were fairly small, and mostly covered with a white, pale brown, or greenish down. A few smooth, dark brown seeds were present. Twenty-five per cent. of the seeds examined were withered.

The cotton was of uneven strength, some portions being very weak. The length of the fibres was irregular, varying from 0·8 to 1·7 in., mostly from 1·0 to 1·5 in. Their diameter ranged from 0·00055 to 0·00090 in., with an average of 0·00070 in.

From the irregularity of the staple it appears probable that this cotton was grown from mixed seed. The ginned cotton was valued at about 8*d.* to 8½*d.* per lb.

No. 30. *Bukedi. Hand-picked and passed through cleaning machine.*—The yield of lint in this case was 34·3 per cent., or 5·16 grams per 100 seeds. The lint was soft, lustrous, of pale cream colour, clean, and free from stains. The seeds were similar to those of No. 28, but only 15 per cent. of those examined were withered.

This cotton was somewhat weak; the dimensions of the fibres were the same as in No. 28.

The hand-picking had greatly improved the appearance of this Bukedi cotton as compared with sample No. 28, since it had removed not only the stained portions of the lint but also some of the immature fibres. The colour of this hand-picked cotton was very good. The ginned cotton was valued at 9·50*d.* per lb.

No. 31. *Bukedi. Hand-picked and roller-ginned.*—This sample was similar to the lint of No. 29 in appearance, but the fibres varied in length from 0·8 to 1·5 in., being mostly from 1·1 to 1·3 in.; in diameter they ranged from 0·0006 to 0·0009 in., with an average of 0·00072 in.

The remarks made on sample No. 29 apply also to this cotton, which was valued at the same price.

No. 32. *Buddu. Passed through cleaning machine.*—This sample yielded 38·3 per cent. of lint, the yield per 100 seeds being 4·84 grams. The lint was fairly soft, lustrous, of cream colour, with some yellow stains. The seeds were small and mostly covered with a white or brown down. Some smooth, dark brown seeds were also present. Thirty-eight per cent. of those examined were withered.

This cotton was also somewhat weak. It varied in length from 0·9 to 1·4 in., but was mostly from 1·1 to 1·3 in. The diameter ranged from 0·00065 to 0·00090 in., with an average of 0·00078 in.

This sample was of fair quality and resembled the Buddu cotton previously examined at the Imperial Institute (No. 28), but it was somewhat softer than the latter. The ginned cotton was valued at 8·50*d.* per lb. The value of the product would have been greater if it had been free from stains and of greater strength.

No. 33. *Buddu cotton. Roller-ginned.*—This sample closely resembled the lint obtained from No. 32, and may be described in the same terms.

In December 1910 several samples (Nos. 34–37) of Improved American Upland seed-cottons, grown experimentally at the Namenage Farm, Busoga District, were received, together with a sample (No. 38) of the variety commonly in cultivation throughout the Protectorate, grown

on the same farm. These were examined with the following results. At the date of the valuation of the samples "good" machine-ginned Broach was valued at $7\frac{7}{16}d.$ and "middling" American at $8·27d.$ per lb.

No. 34. *King.*—This sample yielded on ginning 38·5 per cent. of lint, the yield per 100 seeds being 6·29 grams. The lint was clean, soft, rather lacking in lustre, of white to pale cream colour, and almost free from stains. The seeds were fairly large, and mostly coated with a white or grey velvety down; a few black seeds bearing a white fuzz at one end were also noticed. The seeds were in good condition; only 6 per cent. of those examined were defective, about 3 per cent. being mouldy and 3 per cent. withered.

The cotton was of good strength and varied in length from 0·9 to 1·2 in., but was mostly from 1·0 to 1·1 in. The diameter ranged from 0·0006 to 0·0011 in., with an average of 0·00083 in.

This seed-cotton gave a large yield of lint, which was rather short in staple and would therefore compete with Indian cotton. It was valued at $7·50d.$ per lb., ginned.

No. 35. *Toole.*—The yield of lint in this case was 40·4 per cent., or 6·49 grams per 100 seeds. The lint was clean, fairly soft, rather lacking in lustre, of cream colour, and almost free from stains. The seeds were large, in some cases covered with a whitish down, whilst others were smooth and black, and usually bore a tuft of down at one end. The seeds were in good condition, only 2 per cent. being defective.

The strength of the cotton was good, but the length somewhat irregular, varying from 0·9 to 1·4 in., mostly from 1·1 to 1·2 in. The diameter ranged from 0·0005 to 0·0010 in., with an average of 0·0008 in.

This seed-cotton also gave a large yield of lint, which was somewhat short and irregular in staple, but was otherwise of fairly good quality. The ginned cotton was valued at $7·75d.$ per lb.

No. 36. *Simpkins.*—This sample yielded 38·2 per cent. of lint on ginning, the yield per 100 seeds being 6·24 grams. The lint was clean, fairly soft, rather dull, of cream colour, and almost free from stains. The seeds were large, mostly

covered with a white or greenish down or fuzz; a few black or dark brown seeds, partially coated with down, were also present. The seeds examined were in good condition; only 8 per cent. were defective, about 3 per cent. being mouldy, and 5 per cent. withered.

The cotton was rather weak, and varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·0 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00081 in.

This seed-cotton gave a fairly large yield of lint, which was somewhat weak and rather short, but otherwise of fairly good quality. It was valued at 7·75*d.* per lb., ginned.

No. 37. *Sunflower* (*acclimatised three years in British East Africa*).—The yield of lint in this sample, viz. 31·8 per cent., or 5·28 grams per 100 seeds, was less than that of the preceding samples. The lint was clean, soft, of good lustre, of white to pale cream colour, and almost free from stains. The seeds were generally of medium size, and mostly coated with a white down or fuzz; a few dark brown seeds partially covered with down were also noticed. The seeds examined were in good condition; only 8 per cent. were defective, 6 per cent. being mouldy, and 2 per cent. withered.

The strength of this cotton was good, but the length irregular, varying from 0·9 to 1·7 in.; mostly from 1·2 to 1·4 in. The diameter ranged from 0·0005 to 0·00085 in., with an average of 0·00069 in.

This cotton was of good quality but irregular length. It was valued at 9·0*d.* per lb., ginned.

No. 38. *Uganda.*—This sample yielded on ginning 36·1 per cent. of lint, or 5·87 grams per 100 seeds. The lint was clean, soft, lustrous, of white to pale cream colour, and free from stains. The seeds were generally fairly large, mostly covered with a white or green fuzz; a few dark brown seeds, sparsely coated with white down, were also noticed. The seeds were in good condition, only 2 per cent. of those examined being withered.

This cotton also was of good strength, but somewhat irregular in length, varying from 1·0 to 1·5 in.; mostly

from 1·1 to 1·3 in. The diameter ranged from 0·0006 to 0·0010 in., with an average of 0·00078 in.

This cotton, which was of American Upland type, was of good strength and colour, and of fairly good length. It was valued at 8·75*d.* per lb., ginned.

The examination of these cottons showed that Nos. 34, 35, and 36 were of rather short staple and somewhat low value, and were consequently inferior to the acclimatised Uganda cotton which was at that time being grown.

The "Sunflower" cotton (No. 37) was of excellent quality, but of rather irregular length. It was recommended that the acclimatisation of this variety should be continued (*cf.* this BULLETIN, 1912, **10**, 429, 481).

The acclimatised Uganda cotton (No. 38) was also of excellent quality, and promises well for the future of the industry.

Of the following six samples of seed-cotton (Nos. 39–44) received in January 1913 the first three were grown at the Government Experimental Plantation, Kadungoro, and the remainder by natives in different districts of the Eastern Province. At the date of the valuation of the samples "middling" American was quoted at 6·85*d.*, and "fully good fair" Abassi at 10·45*d.* per lb.

No. 39.—This sample yielded on ginning 28·4 per cent. of lint, the yield per 100 seeds being 4·16 grams. The lint was clean, soft, fine, lustrous, slightly "leafy," light cream in colour, and showing a few small yellow stains. The seeds were of medium size, and covered with a fairly long white fuzz.

The cotton was of irregular strength, but fair on the whole; some weak immature fibre was present. The length of the fibres varied from 1·2 to 1·9 in., but was mostly from 1·5 to 1·7 in.

This cotton was of excellent quality, except for a little irregularity in strength. It was valued at 8·25*d.* per lb., ginned.

No. 40.—The yield of lint in this case was 29·6 per cent., or 4·52 grams per 100 seeds. The lint was similar to that of No. 39, whilst the seeds were of medium size, and in most cases covered with fairly long white or

brownish fuzz; a few smooth or almost smooth dark brown seeds were also present.

The strength of the cotton was irregular, but fair on the whole, though some weak undeveloped fibre was present. The length was also irregular, varying from 1·0 to 1·8 in.

The ginned cotton was valued at 7·75*d.* per lb., its value being depreciated by its uneven length and strength.

No. 41.—This sample yielded on ginning 29·3 per cent. of lint, the yield per 100 seeds being 4·32 grams. The lint was clean, soft, fine, somewhat curly, of rather good lustre, of cream colour, and practically free from stains. The seeds were of medium size, and mostly covered with rather long white or greenish fuzz, but some almost smooth dark brown seeds were also present which had a small tuft of fuzz at the pointed end.

The strength of the cotton was irregular, and on the whole rather poor. A fair proportion of weak undeveloped fibre was present. The length was also rather irregular, varying from 1·0 to 1·6 in., but was mostly from 1·2 to 1·4 in.

This cotton showed the same defects as the preceding sample, No. 40, and though rather more regular in length it was somewhat weaker. It was valued at 7·40*d.* per lb., ginned.

No. 42. *Cotton grown by natives at Kumi, Eastern Province.*—The yield of lint from this sample was 33·4 per cent., the yield per 100 seeds being 5·09 grams. The lint was clean, fairly soft, fine, lustrous, of cream colour, and free from stains. The seeds were mostly of medium size, and covered with long white fuzz, or medium-length green or brownish fuzz; but about 16 per cent. were clean or almost clean dark brown seeds, with a small tuft of white fuzz at the pointed end.

The strength of the cotton in this case also was irregular, and rather poor on the whole. The length was rather irregular, varying from 0·9 to 1·6 in.; mostly from 1·3 to 1·5 in.

This cotton was uneven in length and strength, like the preceding samples, Nos. 40 and 41, but it was not quite so soft. It was valued at 7·25*d.* per lb., ginned.

No. 43. *Cotton grown by natives at Sambwe, Serere County, Eastern Province.*—This sample yielded 31·9 per cent. of lint on ginning, the yield per 100 seeds being 4·82 grams. The lint was similar in appearance to the preceding sample, No. 42, but a few large yellow stains were present. The seeds were of medium size, and covered with short, medium, or rather long white or greenish fuzz; a few almost clean dark brown seeds were present.

The strength of this cotton was rather irregular, but fairly good on the whole. The length varied from 0·8 to 1·4 in., but was mostly from 1·1 to 1·3 in.

The ginned cotton was valued at 6·15*d.* per lb. The length and strength of this cotton were somewhat irregular, and its value was reduced by the presence of stains.

No. 44. *Cotton grown by natives at Bugondo, Serere County, Eastern Province.*—The yield of lint from this sample was 29·0 per cent., the yield per 100 seeds being 4·27 grams. The lint was very similar to that of No. 41, but of a deeper cream colour. The seeds were of medium size and mostly covered with fairly long white or bright green fuzz; some smooth seeds without fuzz were also present, together with a number of undeveloped seeds.

This cotton was also of irregular strength, and poor on the whole. Some weak undeveloped fibre was present. The length varied from 0·9 to 1·6 in., but was mostly from 1·3 to 1·5 in.

This cotton exhibited similar defects to the preceding sample No. 43, and though rather longer it was somewhat weaker. It was valued at 6·40*d.* per lb., ginned.

These six cottons (Nos. 39–44) were all of good appearance, but they were somewhat irregular in staple. They contained an appreciable quantity of weak, immature fibre, which would create a certain amount of waste in the processes preparatory to spinning. This defect might possibly be remedied by allowing the cotton to ripen more completely before it is picked.

No. 45. *Caravonica Silk Cotton.*—This sample of seed-cotton, received in December 1910, was grown at Koba, Nile Province. The yield of lint, on ginning, was 33·5 per cent., the yield per 100 seeds being 5·98 grams. The lint

was clean, somewhat harsh, lustrous, white, and free from stains. The seeds were large, smooth, and dark brown, mostly bearing a small tuft of white fuzz at the pointed end. Forty-eight per cent. of the seeds examined were defective, 46 per cent. being mouldy and 2 per cent. withered. They would be useless for sowing.

The cotton was of good strength, but somewhat irregular in length, varying from 1·2 to 2·0 in., but mostly from 1·3 to 1·6 in. The diameter ranged from 0·0005 to 0·0009 in., with an average of 0·00072 in.

This material was somewhat harsh for Caravonica silk cotton, but it was of very good quality, and was valued at about 11*d.* per lb., ginned, with "good" moderately rough Peruvian at 10·50*d.* per lb. The cultivation of this or any other tree-cotton in Uganda cannot be recommended on account of the tendency of such plants to harbour insect and fungoid pests and thus endanger the other cotton of the country. Moreover, the commercial experts reported that there is only a limited demand for cotton of this type.

NEW COLONIAL AND OTHER TANNING MATERIALS

In a previous number of this Bulletin (1907, **5**, 343) some account was given of the results of examination of a large number of tanning materials from the Colonies and India which had been investigated at the Imperial Institute. Since that date a number of other reports and articles dealing with important tanning materials have been published in this Bulletin, especially on wattle bark (1908, **6**, 157; 1910, **8**, 245; 1911, **9**, 116), valonea (1912, **10**, 645), Cyprus sumach (*ibid.* p. 45), Chinese gall-nuts (*ibid.* p. 576), and "teri" pods (*Cæsalpinia digyna*) from India (*ibid.* p. 219). In the present summary it is proposed to give further information on some of the products mentioned in the previous articles, references to which are quoted above, and also to publish the results of examination of a number of other materials which are either new in this industrial application or are new in the sense that they are from countries which do not at present export commercial supplies of these materials.

Many of the products referred to are not rich enough in tannin to be worth export in the raw state as tanning materials, but they are still of commercial interest, since they appear to be suitable for local use either for the preparation of leather for export or for the manufacture of tanning extracts which could be exported. The demand for tanning extracts is steadily increasing, especially in the United Kingdom, and there seems to be no reason why a large proportion of the imports of these products, that now reach the United Kingdom from foreign sources, should not be obtained from the Colonies and India.

Some of the materials referred to are obviously of no value as tanning materials, and they are referred to merely because they have been mentioned elsewhere as suitable for use in this way and it seems desirable to put the results of their examination on record so that they may be available for reference.

Black Wattle Bark from the East Africa Protectorate

Reference has already been made in this Bulletin (*loc. cit.*) to the cultivation and production of wattle bark in various British territories, and the results of examination at the Imperial Institute of samples of the bark from South Africa and the East Africa Protectorate have been also published (1908, **6**, 165; 1910, **8**, 245). The planting of black wattle has made considerable progress in the East Africa Protectorate in recent years, and an Ordinance has been enacted for the protection of the industry (this Bulletin, 1912, **10**, 479).

The cultivation of black wattle in the Protectorate is carried on chiefly in the Limoru, Kikuyu, Njoro, Makuru, Londiani, and Lumbwa districts. On March 31, 1911, there were 800 acres planted with trees three years old and over, whilst during the preceding fifteen months about 2,000 acres were planted out, and further extensive areas were being prepared for sowing. Wattle bark first appears in the published export figures for the Protectorate in 1911–12, when 10 tons were exported.

At the present time the chief sources of the wattle bark

used for tanning purposes in Europe are Australia and South Africa. The exports from these countries in recent years are shown in the following table. The figures for the Australian Commonwealth are for "tanning bark," and probably include a certain proportion of mallet bark.

	Union of South Africa.		Commonwealth of Australia.	
	Cwt.	£	*Cwt.*	£
1910 . .	826,875	219,433	295,616	119,254
1911 . .	992,904	289,557	253,556	104,646
1912 . .	1,055,527	283,060	figures not available.	

A number of samples of black wattle bark from the East Africa Protectorate have been received at the Imperial Institute in recent years, and these are dealt with in the following pages :

No. 1.—This sample of black wattle bark, received in December 1910, was obtained from trees planted in November 1903, near Kikuyu. It consisted of quills of bark about 3 ft. long and varying from ⅛ to ¼ in. in thickness. The bark was dark brown externally, the thinner quills being smooth, whilst the thicker ones were wrinkled ; internally it was smooth and brown. The bark gave a fibrous fracture, the broken surface being almost white.

The following table shows the results of examination of (1) an average sample, and (2) of some of the thicker pieces of bark in the consignment :

	Average sample from the consignment.	Thick bark only.
	Per cent.	*Per cent.*
Moisture	9·5	12·4
Ash	2·4	2·1
Tannin	35·7	43·1
Extractive matter (non-tannin) . .	9·6	8·6
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell . *Red*	6·2	4·5
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell . *Yellow*	6·6	5·5

The bark yielded a rather soft leather of a pale pink colour.

A small lot of this bark was offered for sale in London through brokers, and was finally disposed of at a rate of about £7 10*s.* per ton delivered in London.

The price of chopped Natal wattle bark at the time of

the report ranged from £8 to £8 10s. per ton, so that having regard to the fact that this consignment of East African bark was small and consisted of mixed thin and thick bark of varying quality and colour, the price obtained for it must be regarded as very satisfactory.

No. 2.—This sample was obtained at Njoro, and was received in August 1911. It consisted of pieces of bark about 7 in. long and ¼ in. thick. The outer surface of the bark was fairly smooth and dark greyish-brown, whilst the inner surface was smooth and brown. The bark gave a fibrous fracture of pink colour.

This bark was analysed, with the following results:

	Per cent.
Moisture	13·6
Ash	2·4
Tannin	39·2
Extractive matter (non-tannin)	9·6

The bark yielded with split calf-skin a slightly pinkish-brown leather of a fairly soft but firm texture.

This bark was of good quality and was valued as probably worth about £8 per ton in London (December 1911), when Natal wattle bark was selling at £6 5*s.* to £10 per ton, according to quality.

No. 3.—This bark, which was received in October 1911, was stated to have been obtained from a tree 16 in. in girth, growing in a closely-spaced plantation of trees about 5½ years old and averaging 50 ft. in height, and it was desired to ascertain whether the percentage of tannin in the bark of the trees was affected by the conditions under which they were grown.

The sample consisted of quills of bark 2 ft. 6 in. in length, and varying from $\frac{1}{16}$ to ¼ in. in thickness. The outer surface was dark reddish-brown and fairly smooth, whilst the inner was light brown, smooth, and fibrous. The bark showed a pink fibrous fracture.

In order to make a fair comparison between this sample and previous samples of wattle bark from the East Africa Protectorate, it was necessary to ascertain the composition of the thick and thin barks separately. Analyses were therefore made of (1) the original sample of mixed bark;

(2) the thin bark, forming 86 per cent. of the total; and (3) the thick bark, forming 14 per cent. of the total. The results were as follows:

	Whole sample.	Thin bark.	Thick bark.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·0	9·8	10·0
Ash	2·6	2·6	2·7
Tannin	30·5	29·4	34·1
Extractive matter (non-tannin)	11·6	12·6	10·6
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	4·7	5·3	4·3
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	7·0	9·1	6·0

The bark furnished a pale pinkish leather of firm texture.

The above results illustrate the importance of keeping thick and thin wattle bark separate for export, since the former is almost invariably richer in tannin and of better colour than the thin bark, and realises better prices.

The present sample contained less tannin than any specimen of wattle bark yet received at the Imperial Institute from the East Africa Protectorate. The average amount of tannin in commercial wattle bark is, however, only 32 per cent., so that in this instance the thick bark is a little above the average, whereas the thin bark is below it.

In a letter relating to this sample the Conservator of Forests stated that it was obtained from a single tree in a plantation, the trees of which were raised from seed sown *in situ* 4 ft. by 4 ft. apart in February 1906, so that when the bark was collected in October 1911 the tree was about 5½ years old. The plantation was stated to have been thinned in September 1908, but no information was supplied as to the spacing round this particular tree after thinning. In Natal it is customary to grow wattle trees with a spacing of 12 ft. by 6 ft., or to sow them 6 ft. by 6 ft. and to thin to 12 ft. by 6 ft. in the fifth or sixth year. Under these conditions the bark is often thick enough and rich enough in tannin to be worth harvesting after five years, though usually the trees are allowed to grow for from seven to ten years before being stripped.

It is clear from these results that under the conditions prevailing in the plantation from which this sample of bark

was obtained, wattle trees will not yield bark very rich in tannin in from 3½ to 4½ years, as was the case with the trees furnishing some previous samples examined at the Imperial Institute (Nos. II., III., and IV. in the table on p. 408; see also this BULLETIN, 1910, **8**, 249). There is, however, no reason to suppose that the trees in this plantation will not give bark of normal richness in tannin after the lapse of another year or two.

Five samples of bark obtained from trees growing in close plantations at Njoro were received in August 1912. They were as follows:

No. 4.—Pieces of bark measuring from 3 to 4 in. in length and up to 1½ in. in width. The thickness was generally less than ⅛ in. The bark was rough and greenish-brown externally, and smooth and pinkish-brown internally. The fracture was fibrous.

No. 5.—Broken pieces of bark, resembling those of the preceding sample No. 4, but smaller in size, rather thicker on the whole, and of a reddish tint externally.

Nos. 6, 7, *and* 8.—Pieces of bark resembling sample No. 4, but rather larger.

Samples 4–8 were examined with the following results:

		No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture		9·9	10·2	10·9	11·1	11·4
Ash		3·2	3·3	2·7	3·3	3·8
Tannin		36·9	37·2	36·7	35·9	36·3
Extractive matter (non-tannin)		12·6	13·8	12·5	11·8	11·5
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell.	*Red*	3·4	4·0	5·0	3·9	5·0
	Yellow	4·9	6·7	8·0	5·7	10·0

The percentage of tannin in these samples (Nos. 4–8) was slightly below that usually present in wattle barks from the East Africa Protectorate (cf. table on p. 408). This was probably due to the fact that the trees furnishing the samples were only three years old, though it may be added that two previous samples of wattle bark from East Africa examined at the Imperial Institute from trees 3½ years old contained as much as 40 per cent. of tannin (Nos. III. and IV. in table on p. 408). These previous samples were, how-

ever, for the most part from more or less isolated trees, and did not, like the present samples, represent the produce of close plantations.

No. 9.—A sample of bark from a tree five years old grown in the Victoria Nyanza Basin at an altitude of approximately 4,000 ft., was received in February of this year. It consisted of pieces of wattle bark, having the usual appearance of this bark and varying in thickness from $\frac{1}{16}$ to nearly $\frac{1}{4}$ in. (mostly from $\frac{1}{8}$ to $\frac{3}{16}$ in.).

It gave the following results on examination :

		Per cent.
Moisture		10·3
Ash		2·9
Tannin		36·9
Extractive matter (non-tannin)		11·2
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell	*Red*	5·2
	Yellow	5·5

The bark yielded a fairly pale leather, with the slightly purplish tint usually given by wattle bark.

This bark was of good quality and contained an average amount of tannin. It was submitted for valuation to a London firm dealing in tanning materials and to two similar firms in Hamburg. The London firm reported that the quality and condition of the bark were good, and that if shipped in bags it would be worth £7 10*s.* per ton c.i.f. London (May 1913). One of the German firms reported that the condition and appearance of the bark were excellent, and that if shipments of similar quality could be made they should realise 2*s.* 6*d.* per ton over the ordinary market price. The firm evinced great interest in the bark, and expressed a desire to receive consignments for sale on the Hamburg market. They added that it would be better to cut the bark into pieces about half as large as those in the present sample.

The second Hamburg firm considered that wattle bark as dry as this sample should compete successfully with the bark shipped from Natal, and valued it at about £7 1*s.* 3*d.* per ton c.i.f. Hamburg. They considered that it might even realise a higher price than Natal bark, and suggested that a trial shipment of about 25 tons should be consigned

to them for sale in order to test the market and afford a basis for further trade.

It is clear from the opinions quoted above that consignments of wattle bark of the quality of the present sample would be readily saleable in either London or Hamburg.

As a considerable number of samples of black wattle bark from the East Africa Protectorate have now been examined at the Imperial Institute, the results obtained are summarised in the following table for convenience of comparison :

Number of sample.	Age of tree.	Moisture.	Ash.	Tannin.	Extractive matter (non-tannin).	Value in London.
Samples previously examined at the Imperial Institute.	*Years.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ton.*
I.	5	12·9	2·4	38·4	12·2	£8 (March 1910)
II.	4½	9·0	2·7	43·6	10·4	£8 (March 1910)
III.	3½	10·6	3·2	39·6	11·2	£8 5*s.* (March 1910)
IV.	3½	9·9	3·0	40·3	10·3	£8 10*s.*–£8 15*s.* (March 1910)
V.	6½	11·9	1·9	35·8	12·2	£8 10*s.* (March 1910)
VI.	10	11·4	1·7	39·7	11·8	£8 10*s.* (July 1910)
Present samples.						
1 (average sample)	7	9·5	2·4	35·7	9·6	Sold in London at the rate of £7 10*s.* per ton [1] (February 1912)
1 (thick bark)	7	12·4	2·1	43·1	8·6	—
2	—	13·6	2·4	39·2	9·6	£8 (December 1911)
3	5½	10·0	2·6	30·5	11·6	—
3 (thin bark)	5½	9·8	2·6	29·4	12·6	—
3 (thick bark)	5½	10·0	2·7	34·1	10·6	...
4	3	9·9	3·2	36·9	12·6	—
5	3	10·2	3·3	37·2	13·8	—
6	3	10·9	2·7	36·7	12·5	—
7	3	11·1	3·3	35·9	11·8	—
8	3	11·4	3·8	36·3	11·5	—
9	5	10·3	2·9	36·9	11·2	£7 10*s.* (May 1913)

[1] *Small consignment only* (see p. 403).

Acacia arabica Pods from the Sudan

The pods of *A. arabica* are used for tanning purposes in the Sudan, where they are known as "Sant" pods. They have also from time to time been imported into the United Kingdom, for use as a tanning material, from West Africa, and are known here as "Gambia" pods. They are also used in India under the name "babul" pods. A sample of the whole pods from the Sudan was examined at the Imperial Institute in 1906, and the results showed that they were a very promising tanning material for use in the

United Kingdom (see this BULLETIN, 1906, **4**, 95). The whole pods, as produced in the Sudan, contain on the average about 30 per cent. of tannin, and would be readily saleable in the United Kingdom as a tanning material. It is, however, possible to considerably increase the amount of tannin by lightly grinding the pods to a granular powder and sifting the product to remove seed and some of the fibrous matter which contains no tannin, and the two following samples of "Sant grains" were prepared in this way by the Sudan Forest Department and submitted to the Imperial Institute for examination.

"*Sant Grains*"

The first sample was received in May 1910, and consisted of a granular material composed mainly of yellowish grains with some fibrous matter.

The second sample was a fine powder, of pale buff colour, with a small proportion of minute brownish-black grains.

The results of analyses of the two samples were as follows:

		No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture		5·9	8·5
Ash		3·7	4·2
Tannin		60·9	54·5
Extractive matter (non-tannin)		21·7	20·9
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell	*Red*	not determined	1·1
	Yellow		1·6

The powder yielded a faintly pinkish-white leather of soft but firm texture.

Samples of the material were submitted to a number of firms of tanners and commercial experts, and the more useful reports received were as follows:

(1) A firm of extract manufacturers considered the sample to represent a useful material, but they regarded the powder as an unsuitable form in which to market the pods, and expressed the opinion that the whole pods, compressed into bales, should be shipped from the Sudan.

(2) Another firm of extract manufacturers, after testing the second sample, also stated that there would be little

demand for it in the powdered form, as tanners do not care for finely ground material, but prefer it in the form of an extract (either solid or liquid) soluble in water.

(3) A third firm similarly reported that in the powdered form the material was not suitable for extraction purposes, but they expressed a desire to receive a large sample of the whole pods for trial.

(4) A firm of tanners considered that the powder should be very suitable for the production of light leathers.

These results are somewhat disappointing, since it might have been supposed that a concentrated material of this kind, which is as rich as many of the tanning extracts imported to the United Kingdom, is of very pale colour, and yields leather of good quality, would have been a welcome addition to commercial tanning materials. The general opinion of dealers in tanning materials, and of extract makers, as well as tanners, in the United Kingdom, however, was that the material was not suitable for importation in this form, though almost all the firms consulted thought the whole pods (see below) would find a market here, and one of them valued the whole pods at £8 per ton.

Whole Sant Pods

These were received in December 1912. They consisted of 70 per cent. pod cases and 30 per cent. small, flat, very hard, dark brown seeds. The pod cases freed from the seeds were examined with the following results:

		Per cent.
Moisture		7·8
Ash		4·5
Tannin		38·9 [1]
Extractive matter (non-tannin)		15·7
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell	*Red*	1·3
	Yellow	2·6

[1] *Equivalent to 27·2 per cent. expressed on the whole pods, including the seeds.*

An infusion of the pods yielded a pinkish-white leather which was fairly soft and of firm texture.

The pods were submitted to a commercial expert, who reported that if they could be shipped in commercial

quantities, and at a reasonable price, they should be readily saleable in the United Kingdom. He considered that it would be easier to find a market for large consignments of hundreds of tons than for small quantities of the pods.

Acacia arabica Pods from Northern Nigeria

A sample of these pods from Kontagora, Northern Nigeria, was received in May 1907.

It consisted of dark brown pods made up usually of three to five segments, each containing one seed. The pods were covered with a fine bloom, which was not easily rubbed off. On breaking the pods transversely a brown, transparent, gum-like material, which was highly astringent, was found between the inner and outer layers of the skin of the pod.

The whole pods, including the seeds, gave the following results on analysis:

	Per cent.
Moisture	11·24
Ash	2·80
Tannin	26·69
Extractive matter (non-tannin)	15·38

The pods tanned calf-skin rapidly, and yielded a pale, fawn-coloured, but rather soft leather.

This sample of *A. arabica* pods contained rather less tannin than those from the Sudan (see p. 410).

As already stated, West African *A. arabica* pods are sometimes imported to the United Kingdom under the name of "Gambia pods."

Pods of *Acacia arabica* var. *Kraussiana* from South Africa

A sample of the pods of this variety of *A. arabica* was received from the Trades Commissioner to the Government of South Africa in December 1911. The pods were thin, blackish-brown, brittle, and were nearly all broken. They were ⅜ in. in width, and were divided transversely into numerous segments, each of which contained a small, flat, shrivelled seed.

The pods were analysed with the following results:

	Per cent.
Moisture	11·6
Ash	3·7
Tannin	19·6
Extractive matter (non-tannin)	20·8

An infusion of the pods gave a rather stiff greyish-brown leather of firm texture.

These pods contained only 19·6 per cent. of tannin, but the leather they produced, although of inferior colour, was of good quality. If employed in conjunction with some other tanning material of better colour the pods should prove very satisfactory for use in South Africa, but it is improbable that the pods would find a market in Europe.

Talh Bark (Red Variety) from the Sudan

A sample of this bark, the product of *Acacia Seyal*, was received from the Sudan in May 1910. It consisted of small, irregularly-shaped pieces of fibrous bark; the outer surface was smooth and dull green, and the inner very pale cream colour. The fracture was dark brownish-red. The bark gave the following results on analysis:

	Per cent.
Moisture	9·4
Ash	6·7
Tannin	18·1
Extractive matter (non-tannin)	13·1

The bark produced a rather harsh leather of dull, dark reddish-brown colour.

This bark contained a fair quantity of tannin, but yielded leather which was too dark-coloured and red to be satisfactory. The bark might be used locally as a tanning agent in admixture with a better and lighter-coloured material, but it is unsuitable for export to Europe.

Acacia longifolia Bark from Cyprus

A sample of the bark of *A. longifolia*, Willd., was received from Cyprus in May 1909. It consisted of quills of thick bark from 8 to 12 in. long. Externally the bark was dark rusty-brown in colour and much fissured; internally it was dull purplish-brown and fairly smooth. The fracture

was very fibrous. The bark gave the following results on analysis:

	Per cent.
Moisture	10·9
Ash	4·0
Tannin	15·3
Extractive matter (non-tannin)	7·5

The bark produced a rather harsh dull brown leather with a purplish tint. It would be suitable for local use as a tanning agent, especially if used in admixture with a lighter coloured tanning material, but it is too poor in tannin to be worth exporting. The amount of tannin found in this sample from Cyprus is similar to that recorded for *A. longifolia* bark in Australia.

Acacia cyanophylla Bark from Cyprus

Two samples of the bark of *A. cyanophylla*, Lindl., have been received from Cyprus.

No. 1. This sample, received in May 1909, consisted of quills of thick bark about 9 in. long. The exterior was dull brown and smooth; the interior pale to reddish-brown. The fracture of the bark was fibrous.

No. 2. This, received in June 1910, consisted of quills of bark measuring 9 in. in length and 1¼ in. in diameter. The quills were light greyish-green and generally smooth externally, and reddish-brown on the inner surface.

The results of analyses of the two samples were as follows:

	No. 1. Per cent.	No. 2. Per cent.
Moisture	15·5	15·7
Ash	3·5	5·3
Tannin	19·5	16·3
Extractive matter (non-tannin)	12·4	10·0

Sample No. 1 produced a rather harsh, dull brown leather with a purplish tint. Sample No. 2 produced a rather stiff, light brown leather.

The results of the chemical examination indicate that the bark contains too little tannin to be worth exporting, especially as the leather produced does not exhibit any marked feature, such as might specially recommend the bark as a tanning agent. The bark should, however be a

good tanning material for local use in Cyprus, either alone or in conjunction with a milder material producing a lighter-coloured leather.

Sample No. 2 was stated to have been collected from ten-year-old trees, so that by analogy with other species of Acacia there is little hope of bark richer in tannin being obtained from *A. cyanophylla* in Cyprus.

Anogeissus leiocarpa Bark from Southern Nigeria and the Sudan

A sample of the bark and roots of *A. leiocarpa*, Guill. & Perr., was received from Southern Nigeria in June 1911, and one of the powdered bark of this plant from the Sudan in August 1911.

That from Southern Nigeria consisted of (1) roots bearing thin bark, (2) small pieces of wood covered with fairly thick bark, and (3) loose pieces of bark. The thick bark alone was examined in detail. It varied from $\frac{1}{16}$ to $\frac{1}{4}$ in. in thickness, and had a non-fibrous fracture varying in colour from yellow to brown. The inner surface of the bark was smooth and blackish-brown, whilst the outer surface varied from smooth to rough, and was brown with greyish patches.

The sample from the Sudan consisted of a fine powder, of a rather dark brownish-buff colour.

The two samples gave the following results on examination:

		Sample from Southern Nigeria. *Per cent.*	Sample from the Sudan. *Per cent.*
Moisture		10·9	8·5
Ash		12·8	13·8
Tannin		17·1	9·6
Extractive matter (non-tannin)		9·4	10·8
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell	*Red*	10·6	11·7
	Yellow	29·3	28·6

The Southern Nigeria specimen yielded a yellowish-brown leather of stiff and somewhat harsh texture, whilst the powdered bark from the Sudan yielded a stiff leather of firm texture and greyish-buff colour.

Neither material was rich enough in tannin to be profitably exported, but the bark could be used locally for

tanning purposes, especially in conjunction with a better material, such as *Acacia arabica* pods. It could probably also be used for the manufacture of tanning extracts

MANGROVE BARKS FROM SOUTHERN NIGERIA

Mangroves occur in great abundance on the west coast of Africa, but so far they have not been utilised as a source of bark. Mangrove barks from various parts of West Africa have been examined by different investigators, and all the results go to show that the bark is invariably of poor quality, compared with that obtained in British and Portuguese East Africa, which may contain as much as 45 per cent. of tannin (compare this BULLETIN, 1907, **5**, 346).

Series I

Four samples of mangrove bark were received in December 1910. They were as follows:

No. 1. "Akoriko."—Strips of bark, somewhat curved, about 1 ft. long and 2 in. wide, and from ⅛ to ¼ in. thick. The strips were brown on the exterior surface; the outer bark had been removed, leaving a soft, cork-like covering. The inner surface was smooth, dark brown, and fibrous. The fracture was very fibrous.

No. 2. "Egba."—Small pieces and chips of heavy red bark of varying thickness up to ½ in. Externally the bark was rough and greenish-grey, whilst the inner surface was rough, dark red, and fibrous. The fracture was somewhat soft.

No. 3. "Ogbunda."—Small broken pieces of bark from ¼ to ⅜ in. thick. Externally the bark was fairly smooth, and whitish with brown markings; the inner surface was also fairly smooth, but of reddish-brown colour. The fracture was hard and woody.

No. 4. "Ikate."—Small pieces and chips of bark about ⅛ in. thick, with some dust. The bark was rough and grey externally, whilst the inner surface was smooth and brown. The fracture was somewhat fibrous on the inner surface of the bark.

These four barks were analysed with the following results:

	No. 1.	No. 2.	No. 3.	No. 4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	11·0	11·5	12·6	11·0
Ash	3·2	3·7	2·9	8·4
Tannin	1·9	16·8	12·9	3·8
Extractive matter (non-tannin) .	4·9	5·6	6·1	2·6

Bark No. 2 furnished a pale pinkish-brown leather of fairly stiff texture, whilst that produced by No. 3 was pale brown and of fairly stiff texture, but rather more pliable than that from No. 2. The percentage of tannin in Nos. 1 and 4 was too small to render them of value as tanning materials.

Series 2

Five samples of mangrove bark known by the Jakri name "Egbadedu," from different localities in Southern Nigeria, were received in December 1911. They were as follows:

No. 5. From Koko. Obtained from a tree 4 ft. 6 in. in girth.

No. 6. From Nana Creek. The tree from which this sample was obtained was 2 ft. 4 in. in girth.

No. 7. From Escravos river. Girth of tree, 4 ft. 9 in.

No. 8. From Forcados river. Girth of tree, 4 ft.

No. 9. From Ramos river. Girth of tree, 4 ft. 2 in.

The barks were all very similar in appearance and consisted of typical thick mangrove bark with a whitish-brown layer on the outer surface. The inner surface was fibrous and of dark red colour. When cut across, the bark showed a large number of white specks.

The barks were examined with the following results:

		No. 5.	No. 6.	No. 7.	No. 8.	No. 9.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture		14·5	14·4	15·5	13·9	13·4
Ash		3·8	4·4	3·8	4·1	4·4
Tannin		22·0	17·4	27·7	16·8	14·9
Extractive matter (non-tannin)		5·7	7·4	8·7	5·0	6·2
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell.	*Red* .	21·6	27·6	30·9	33·3	28·8
	Yellow	28·4	28·7	36·1	29·8	30·8
Character of the leather produced.		Pale reddish-brown, fairly stiff, of firm texture.	Similar to No. 5, but slightly darker.	Similar to No. 6.	Similar to No. 5, but slightly redder.	Similar to No. 8.

Series 3

Three samples of bark from Degema, Eastern Province, were received in May 1912.

No. 10. Red mangrove bark (*Rhizophora* sp.).—The sample consisted of fragments of thick bark, greyish-brown to brown externally, and brown and rough on the inner surface. The fracture was characteristic of mangrove bark.

The material was damp on arrival at the Imperial Institute, and was air-dried before being analysed. The loss of weight on air-drying was 10·2 per cent.

No. 11. Red mangrove bark (*R. Mangle*).—This sample consisted of irregular fragments of thick bark, greyish-brown in colour and rough externally, but dark brown on the inner surface. The bark showed a characteristic mangrove fracture.

No. 12. White mangrove bark (*Avicennia africana*).—The sample consisted of irregular fragments of moderately thin bark, which was rough and greyish-brown externally and brown on the inner surface. It gave a characteristic mangrove fracture.

The barks were examined with the following results:

	No. 10.	No. 11.	No. 12.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	13·8	16·4	15·8
Ash	6·3	4·8	4·6
Tannin	19·8	17·1	12·5
Extractive matter (non-tannin)	5·2	9·4	9·8
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	25·7	60·3	62·3
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	33·7	22·1	31·9
Character of the leather produced.	Rather harsh, of pale brown colour and firm texture.	Similar to No. 10.	Similar to No. 10, but darker in colour.

Some of these samples of mangrove bark from Southern Nigeria, especially Nos. 5 and 7, contained a higher percentage of tannin than is usually present in West African mangrove barks, but none of them was rich enough to be worth exporting to Europe in competition with East African mangrove bark. All except Nos. 1 and 4 would, however, be quite suitable for local use in the Colony, or for the manufacture of mangrove cutch for export.

Mangrove Leaves from the East Africa Protectorate

Two samples of mangrove leaves were received from the East Africa Protectorate in July 1908.

The stems of the East African mangrove trees are now used for "boriti" poles, for which there is a large demand along the East African coast. The bark, which is very rich in tannin, is collected for export; but the leaves are not utilised, and these samples were forwarded for examination in order to ascertain whether they contained enough tannin to make them of commercial value.

No. 1. From a large tree.—This consisted of dry, reddish-brown, coriaceous, oval leaves, from 3 to 4 in. in length and with a maximum width of 2½ in. They had a distinctly saline taste.

No. 2. From a young tree.—Dried, dark reddish-brown leaves of similar appearance and size to the preceding sample.

The samples were examined, with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	18·52	18·73
Ash	9·92	9·37
Tannin	9·13	8·78
Extractive matter (non-tannin)	18·80	20·72
Sodium chloride	5·78	6·87
Sodium chloride in total soluble solids	19·60	24·53

An extract of the leaves in each case tanned skin extremely slowly. No. 1 produced a light reddish, harsh leather of poor quality, whilst that produced by No. 2 was similar but of slightly darker shade.

The amount of tannin in these leaves is far too low to render them of value for export. It is, moreover, doubtful whether such material would be suitable for local use, as, on account of the large percentage of salt (sodium chloride) which the leaves contain, they tan very slowly and yield a leather of poor quality.

Mangrove Extract from Fiji

Three samples of mangrove extract from Fiji were received early in 1912, and were examined with the following results:

No. 1.—This consisted of a soft cake of very dark

reddish-brown, friable material, which had a vitreous fracture. The extract was not completely soluble in water.

No. 2.—This was an almost black powder, together with some lumps of friable material. It was not completely soluble in water, and gave a very deep-coloured infusion, indicating that it had probably been overheated during preparation.

No. 3.—This consisted of particles of dark brown friable extract, which was not completely soluble in water.

The samples were examined with the following results, compared with those afforded by a sample of commercial Borneo cutch, previously examined at the Imperial Institute.

	No. 1.	No. 2.	No. 3.	Borneo cutch.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	26·3	15·8	13·1	15·90
Ash	3·1	7·5	6·4	2·12
Tannin	59·5	55·3	69·4	66·20
Extractive matter (non-tannin)	12·8	22·7	15·3	16·50
Colour of 0·5 per cent. tannin solution in a 1 cm. cell. *Red*	36·1	150·0	25·8	Not determined
Colour of 0·5 per cent. tannin solution in a 1 cm. cell. *Yellow*	28·0	-	28·8	
Character of leather produced.	Reddish-brown, very stiff, of firm texture.	Similar to No. 1, but very dark in colour.	Reddish-brown, of firm texture.	Pinkish-buff, of good texture.

None of these samples of mangrove cutch from Fiji except perhaps No. 3 would be suitable for tanning leather without decolorisation, but they could be used, like commercial mangrove cutch, for dyeing sails, fishing nets, etc.

Samples 1 and 2 were submitted to commercial experts, who stated that their full value, packed in strong 1 cwt. cases, would be about £14 per ton c.i.f. Liverpool (June 1912). Sample No. 3 was of rather better quality, and should realise a somewhat higher price. The prices ruling for mangrove cutch in 1912 in the United Kingdom ranged from £11 to £14 10s. per ton, according to quality.

Brachystegia Barks from Mozambique

Three samples of bark, gathered from three distinct species of Brachystegia at Mocoque, in the Mozambique Company's Territory in Portuguese East Africa, were

received for examination in February 1912. They were as follows:

No. 1.—Small pieces of bark, ¼ to ½ in. thick, greyish-brown in colour and varying from smooth to rough externally, and brownish-red and smooth on the inner surface. The fracture was very hard and short.

No. 2.—Small pieces of bark, ¼ to ⅜ in. thick, greyish-brown and rather rough externally, and reddish-brown and smooth on the inner surface. The fracture was very hard and rather fibrous.

No. 3.—Small pieces of bark, ⅛ to ¼ in. thick, greenish-brown and smooth externally, and reddish-brown and smooth on the inner surface. The fracture was hard and rather fibrous.

The results of examination of the barks are given in the following table:

		No. 1.	No. 2.	No. 3.
		Per cent.	*Per cent.*	*Per cent.*
Moisture		10·2	11·0	11·9
Ash		7·0	7·3	6·5
Tannin		18·4	14·1	13·2
Extractive matter (non-tannin)		8·0	7·9	4·1
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell.	*Red*	23·1	14·5	12·8
	Yellow	21·0	24·1	27·1
	Black	3·4	—	—

None of these three barks was sufficiently rich in tannin to be worth exporting to Europe, but they would all be suitable for local use in East Africa. Samples 2 and 3 gave pale-coloured leathers of good texture, whilst No. 1, the richest of the three barks in tannin, yielded a dark-coloured leather, which, however, apart from its colour, appeared to be of good quality. There is a prejudice in Europe against dark-coloured leather, which, therefore, only realises low prices, whilst tanning materials producing such leather are almost unsaleable. Bark No. 1 could, therefore, not be employed for the manufacture of leather or extract intended for export to Europe. Barks Nos. 2 and 3 would probably yield extracts of good quality which would be suitable for export, and this may also be the case with No. 1 if a satisfactory process of decolorisation can be found.

Osyris abyssinica from the Transvaal

Four samples of the dried leaves and twigs of *O. abyssinica*, Hochst. (= *Colpoon compressum*, Berg.) were received from the Transvaal in January 1910. The first two samples described below were collected at Buffelspoort, and the other two near Pretoria. Samples were previously received from South Africa in 1907 under the name of "Cape Sumach" (see this Bulletin, 1906, **4**, 354), but the plant is quite distinct from the true sumach (*Rhus Coriaria*, L.), and possesses different properties.

The samples received in 1910 were as follows:

No. 1.—Dried green leaves and twigs, the latter forming a large proportion of the sample and varying considerably in age, some of them consisting of thin green branches and others of woody branches ¼ in. in thickness.

No. 2.—Dried, thin green branches, with a few rather broken, dry green leaves.

No. 3.—Chiefly dried leaves, together with a few thin green stalks carrying leaves.

No. 4.—This sample resembled No. 3, but contained a larger proportion of leaves.

Samples 2, 3, and 4 produced a pale fawn-coloured leather, fairly soft, but rather porous. Sample No. 1 was somewhat abnormal in giving a rather harsh and brittle leather of pale fawn colour.

The following table shows the results of the analyses of the present samples of *Osyris abyssinica*, as well as of previous samples which have been examined at the Imperial Institute:

	Present samples from the Transvaal (1910).				Previous samples from the Transvaal (1907).		Samples from Somaliland (1905 and 1906).	
	No. 1.	No. 2.	No. 3.	No. 4.	Stems.	Leaves.	Leaves and twigs.	Leaves.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	11·7	7·9	10·5	8·2	11·2	11·2	11·0	10·3
Ash	5·8	5·4	4·2	6·9	not determined		7·1	5·4
Tannin	13·6	18·8	21·6	24·7	12·9	13·6	23·3	24·8
Extractive matter (non-tannin)	18·3	24·6	25·3	26·9	14·6	21·4	13·2	21·8

It will be seen that sample No. 1 contained a low percentage of tannin, resembling in this respect the material previously received at the Imperial Institute from the Transvaal. Samples Nos. 2 and 3 were richer in tannin, but contained less than is usually found in *O. abyssinica* (viz. about 23 per cent.) and less than was present in the samples from Somaliland. No. 4 was the best of the four samples, and was as rich in tannin as the Somaliland material.

The samples from the Transvaal differed greatly in the amount of tannin they contained. In the absence of any particulars regarding them, a full explanation of this variation cannot be given; but judging from analyses of the samples received in 1910, the leaves are generally richer in tannin than the stems, and the latter appear to become less rich in tannin with age. The value of this material as a tanning agent is discussed in the previous report (*loc. cit.*) and the remarks made then apply equally to the present specimens. Samples Nos. 2, 3, and 4 were richer in tannin than those previously examined, and would be suitable for local use, but the material possesses no special qualities which would render it suitable for export to Europe.

"Subakh" Bark from the Sudan

A sample of "Subakh" bark derived from *Combretum Hartmannianum*, Schweinf., was received from the Sudan in May 1910. It consisted of small pieces of almost flat bark; the outer surface was reddish-brown and the inner pale yellowish-brown. The bark was coarsely fibrous, and had a pale pinkish-brown fracture. It was analysed with the following results:

	Per cent.
Moisture	7·6
Ash	10·2
Tannin	12·8
Extractive matter (non-tannin)	11·1

The material tanned very slowly and unevenly, giving a light-coloured leather of poor quality.

This bark might be suitable for local use as a tanning

material, especially in conjunction with a better product such as Sant pods, but it is too poor in tannin to be of any value for export purposes.

The Bark of *Aleurites* spp. from Hong Kong

In 1901 von Schröder published a statement (*Deut. Gerb. Zeit.* 1901, **54**, 6) that the bark of *Aleurites cordata* is rich in tannin, whilst more recently a similar assertion has been made regarding the bark of *A. triloba* (*A. moluccana*). Authentic specimens of the barks of these two trees, as well as of *A. Fordii*, were procured from the Superintendent of the Botanical and Forestry Department at Hong Kong in 1909, and these have been examined at the Imperial Institute with the following results:

No. 1. *A. Fordii.*—Long narrow quills of dull grey bark; the outer surface was rather rough, the inner surface pale and woody.

No. 2. *A. cordata* (*A. montana*, Wilson, see p. 445).—Long strips of fibrous bark, the outer surface of which was dark and striated.

No. 3. *A. triloba.*—Large quills of thin bark, about 18 in. long, and covered with a dark, smooth outer layer; the inner surface was red, but the fracture was white and woody.

The following table shows the results of analyses of these barks:

	A. Fordii.	*A. montana.*	*A. triloba.*
	Per cent.	*Per cent.*	*Per cent.*
Moisture	12·89	13·62	13·59
Ash	7·74	4·68	14·41
Tannin	11·90	6·03	5·70
Extractive matter (non-tannin)	8·70		

The bark of *A. Fordii* produced a rather harsh, but fairly pale-coloured leather of medium quality. This material could be used locally as a tanning agent and would yield leather of fair quality, especially if employed in admixture with a mellower and richer tanning material, such as myrabolans.

The results now recorded do not bear out the statements

referred to in the opening paragraph, since neither the bark of *A. montana* nor that of *A. triloba* contains enough tannin to make it suitable for use as a tanning material, whilst the amount of tannin present in the bark of *A. Fordii* is small. Of the three barks, only that of *A. Fordii* could be used for tanning, but even this material contains too little tannin to be worth exporting, and it would only be suitable for local use.

It seems unlikely that the present results differ from those previously recorded owing to differences in the ages of the trees yielding the barks. The three samples of bark forwarded from Hong Kong were apparently obtained from fairly old trees, and as a rule the percentage of tannin in the bark increases with the age of the tree. It is therefore improbable that the deficiency of tannin in the present specimens is due to collection at too early a stage.

If these samples of various Aleurites barks from Hong Kong may be taken as typical and fairly representative of the barks produced by these trees elsewhere, it would appear that the statements made regarding their richness in tannin are inaccurate, possibly owing to the examination of unauthenticated material.

Phyllocladus rhomboidalis Bark from Tasmania

A sample of the bark of *P. rhomboidalis*, Rich., (celery top pine) was received from Tasmania in May 1912. The sample consisted of two pieces of bark measuring respectively 12·5 by 3·5 by 0·4 in. and 12 by 3 by 0·3 in. The outer bark was dark brown, and gave a brittle fracture of dark purplish-red colour; the inner bark, which formed about 67 per cent. of the total, was yellow to orange-brown, with a fibrous fracture.

The results of analyses of the outer and the inner barks were as follows:

		Outer bark. *Per cent.*	Inner bark. *Per cent.*
Moisture		13·6	11·1
Ash		1·2	2·7
Tannin		24·8	16·7
Extractive matter (non-tannin)		6·6	6·8
Colour (approx.) of 0·5 per cent. tannin solution in a 1 cm. cell.	*Red*	23·8	25·0
	Yellow	25·0	25·0

The proportion of tannin, expressed on the whole of the inner and outer bark, was about 20 per cent.

The outer bark gave a pale purplish, soft leather, of firm texture, and the inner bark a pale orange-tinted leather of similar quality.

Both the inner and outer barks represented by this sample contained too low a percentage of tannin to be remuneratively exported to Europe, but they could be used locally in Tasmania for tanning or for the manufacture of extract.

"Kumbuk" Bark from Ceylon

A specimen of "Kumbuk" bark derived from *Terminalia glabra* was received from Ceylon in August 1910. The bark was smooth, thin, and loosely adherent, greyish-brown externally, and showing a tough, fibrous fracture of bluish-pink colour.

In August 1911 a further sample of the bark was received. This consisted of broken pieces of hard, heavy bark, ½ to 1¼ in. thick, greenish-brown in colour and smooth on the outer surface, and dark brown on the inner surface. The fracture was brittle and showed a pinkish-brown colour.

The two samples were analysed with the following results:

		No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture		11·6	11·1
Ash		9·0	13·1
Tannin		31·6	27·2
Extractive matter (non-tannin)		5·8	6·5
Colour of a 0·5 per cent. tannin solution in a 1 cm. cell.	*Red*	12·3	10·8
	Yellow	26·4	32·8

The bark produced a pale pinkish-brown leather of stiff texture. Trials which have been carried out for the Imperial Institute by a tanning expert have shown, however, that this bark offers certain difficulties in the tanning process which would make it difficult to sell in competition with the large number of rich tanning materials of normal quality now available. An independent trial made by a firm of light leather tanners showed that although the bark could be used commercially for tanning such leather it

yielded a product which was too dark in colour to be acceptable under present conditions.

It does not seem likely that *T. glabra* bark could be profitably exported to the United Kingdom as a tanning material. It could, however, be quite suitably employed in Ceylon in preparing leather either for local use or for export.

Phyllanthus Emblica Leaves from Hong Kong

A sample of the leaves of *P. Emblica*, L., was received from the Superintendent of the Botanical and Forestry Department in Hong Kong in September 1911. The leaves are said to be used in Hong Kong as a black dye-stuff for silk.

The sample consisted of small leaves, about ¾ in. long and ¼ in. broad, varying in colour from pale greyish-green to brown. The leaves were examined at the Imperial Institute both as a tanning material and as a dye-stuff, with the following results:

The leaves were analysed and found to contain:

	Per cent.
Moisture	10·5
Ash	3·4
Tannin	16·8
Extractive matter (non-tannin)	11·9

The colour of a 0·5 per cent. tannin solution in a 1 cm. cell was 4·1 red, 14·9 yellow.

The infusion of the leaves yielded a soft leather of firm texture, and of pale cream colour, with a faint greenish-yellow tinge.

The above results show that the leaves are not rich enough in tannin to be suitable for export to Europe as a tanning material, but that they could be used locally in Hong Kong for tanning purposes, and would produce leather of a good quality.

Experiments carried out at the Imperial Institute showed that, used alone with silk, the leaves gave only a rather dull brownish-yellow tint. When an aluminium mordant was used, aqueous extracts of the leaves gave colours ranging from deep cream to pale yellow, according

to the strength of the extract and the method of treatment employed. By the use of an iron mordant it was found possible to obtain grey and black dyes, as is usually the case with materials containing tannin.

In Watt's *Dictionary of the Economic Products of India* (vol. vi., part i., p. 218 [1892]), the results are recorded of some trials carried out by Wardle, in which the leaves of *P. Emblica* gave light drab or brownish-yellow colours; and, referring to the fruit of the plant, in *Commercial Products of India* (1908, p. 887), Watt states that it gives a blackish-grey dye if used alone, but that it "is generally mixed with salts of iron or the barks of other trees to produce a black." It appears clear from these statements and from the experiments carried out at the Imperial Institute that the leaves of *P. Emblica* cannot be used for dyeing black, except in the presence of iron.

Divi-Divi Pods (*Cæsalpinia coriaria*) from the Gold Coast

A sample of divi-divi pods was received from the Gold Coast in August 1907. Samples from India and Queensland have been previously examined at the Imperial Institute, and the results of analyses of these will be found in this Bulletin (1904, **2**, 93).

The present sample had the usual appearance of divi-divi pods, but the husks were much broken, rather stringy and fibrous in appearance, dull externally and somewhat mouldy internally. A few of the pods had not been separated longitudinally, but were merely broken across, which seems to indicate that they had been collected in an immature condition, when they are difficult to open.

The pods were analysed with the following results:

	Per cent.
Moisture	14·42
Ash	1·22
Tannin	33·10
Extractive matter (non-tannin)	14·63

The material furnished a soft, pale-brown leather of good texture and appearance.

This sample of divi-divi was rather poor in tannin in comparison with the ordinary divi-divi of commerce, which contains from 40 to 45 per cent. of tannin. This fact, and the rather unpleasing appearance of the sample, due to insufficient care having been taken in its preparation, diminished its commercial value. It was valued at £5 per ton as against £9 to £11 per ton obtainable on the same date for West Indian and South American divi-divi.

Divi-divi pods are richest in tannin when just mature, and after collection at this period the pods should be split open longitudinally, the seeds removed, and the husks dried as rapidly as possible in the sun. Slow drying frequently allows fermentation to commence, with the production of red colouring matter which diminishes the value of the material.

ESSENTIAL OILS FROM VARIOUS COUNTRIES

In the following pages an account is given of the results of examination of a number of essential oils from Cyprus, Hong Kong, West Indies, and Zanzibar, which have been received at the Imperial Institute in recent years.

CYPRUS

In addition to the "origanum" and "marjoram" oils from Cyprus to which reference has been made in this Bulletin from time to time, a number of new essential oils have been received from Cyprus during the last few years for examination, and it is of interest to place the results obtained on record, though none of the oils have so far proved to be of much commercial importance. Samples of all the oils are available at the Imperial Institute, where they can be inspected, and small specimens can be supplied to commercial firms interested in these products.

"Juniper" Oil

This product is distilled from the unripe berries of *Juniperus phœnicia*, L., and therefore differs in botanical

origin from the juniper berry oil of commerce distilled from the berries of *J. communis*, L.

The sample was pale yellow in colour, and had a characteristic aromatic odour, differing considerably from that of ordinary juniper oil.

The oil was examined with the following results, which are compared with those of commercial juniper berry oil:

	Present sample.	Juniper berry oil (recorded by Gildemeister).
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·8684	0·867 to 0·875
Optical rotation in 100 mm. tube at 20° C.	+ 3° 4′	Generally lævorotatory, up to − 11°.
Saponification value[1]:		
Original oil . .	9·8	5 to 11
Acetylated oil . .	16·8	21 to 26
Solubility in alcohol	Not soluble to a clear solution in 10 volumes of either 70 or 80 per cent. alcohol. Gives a slightly opalescent solution with 9 volumes of 90 per cent. alcohol.	Soluble in 8 to 10 volumes of 90 per cent. alcohol.

[1] *Milligrams of potash per gram of oil.*

The oil was submitted to two firms of commercial experts, who agreed in the view that it differed greatly in odour from ordinary juniper berry oil, and that it could not be sold as such.

"*Sage*" *Oil*

This oil is distilled from *Salvia cypria*, Unger and Kotschy. The true sage oil of commerce is distilled from *S. officinalis*, L., but oils prepared from other species of *Salvia* are obtainable in commerce though they fetch lower prices than genuine sage oil.

Two samples of the Cyprus oil have been examined.

The first was a pale yellow oil possessing a characteristic odour, somewhat recalling those of camphor and camphor oil. The second was quite similar to the first in appearance and aroma.

These two samples gave the following results on examination; the characters of genuine sage oil are added for comparison;

	Cyprus "Sage" oil.		Genuine Sage oil.
	Sample 1.	Sample 2.	
Specific gravity at $\frac{15° C.}{15° C.}$	0·9263	0·925	0·915 to 0·925
Optical rotation in 100 mm. tube at 20° C.	−6° 31′	−22° 23′	+ 10° to + 25°
Saponification value[1]:			
Original oil	13·9	8	6 to 18
Acetylated oil	38·9	36	Not recorded.
Solubility	In 1 or more volumes of 80 per cent. alchohol.	In 0·8 or more volumes of 80 per cent. alcohol.	In 2 or more volumes of 80 per cent. alcohol.

[1] *Milligrams of potash per gram of oil.*

These results show that the Cyprus oil differs from ordinary sage oil in being lævorotatory, and in being more soluble in alcohol. Further examination showed that it contained a large proportion of cineole (75 per cent. as determined by the resorcinol process) and a small proportion of camphor. Genuine sage oil contains as its chief constituents, thujone, borneol, cineole, and pinene.

Specimens of the Cyprus sage oil were submitted to several firms dealing in essential oils, for opinions as to its commercial value. One or two firms thought it might be sold as a substitute for Spanish sage oil, which was then worth 1*s.* 1*d.* to 1*s.* 4*d.* per lb. (September 1910), but the general view was that the product would not be readily saleable in the United Kingdom unless it was offered at a very low price.

Laurel Leaf Oil

Three specimens of laurel oil distilled in Cyprus from *Laurus nobilis* have been received at the Imperial Institute for examination. The first sample (No. 1) was forwarded early in 1908, the second (No. 2) was received in March 1909, whilst the third (No. 3) was received in July 1909.

It was desired to ascertain whether there would be a market for this oil, of which it was stated considerable quantities could be prepared in Cyprus.

All the samples consisted of clear, yellow oil, possessing the characteristic odour of laurel leaf oil. Sample No. 1 was slightly turbid owing to the presence of moisture.

The oils were examined and furnished the following results, compared with those of commercial laurel leaf oil:

	Sample No. 1.	Sample No. 2.	Sample No. 3.	Commercial laurel leaf oil. (Gildemeister.)
Specific gravity at 15° C.	0·940	0·934	0·9224	0·92 to 0·93
Optical rotation in 100 mm. tube	− 5° 21′	−4° 45′	−11° 32′	−15° to −18°
Solubility in alcohol	Soluble in 1·7 or more volumes of 80 per cent. alcohol.	Soluble in 1½ volumes or more of 80 per cent. alcohol.	Soluble in 1 volume of 80 per cent. and in from 5 to 6 volumes of 70 per cent. alcohol.	Soluble in from 1 to 3 volumes of 80 per cent. alcohol.

Nos. 1 *and* 2 *contained* 66 *and* 71 *per cent. of cineole respectively as determined by the resorcinol process.*

Samples of these laurel oils from Cyprus have been submitted to experts both in this country and on the Continent.

A London firm reported that there is very little demand for laurel oil in this country, although they believed that it is used to a larger extent in Germany and on the Continent generally. They stated that its principal use, so far as they were concerned, would be as a source of cineole (eucalyptol), and mentioned that they were able to buy eucalyptus oil, containing about 78 to 80 per cent. of cineole, at 1*s.* 2*d.* per lb.

Another British firm to whom the oil was submitted stated that there is only a very small demand for it in this country, while a third London firm reported that this oil was not of any interest to them.

In reporting on sample No. 1 commercial experts stated that the aroma was not inferior to that of the laurel oils usually met with in commerce and valued the sample at about 9*s.* per lb. (May 1908).

Sample No. 2 was submitted to commercial experts in Germany, who reported that its odour was quite equal to that of ordinary laurel oil. They stated that the value of good quality laurel oil was about 8*s.* 3*d.* per lb. (May 1909), but pointed out that the present supply of this oil easily covers the demand, and that any further encouragement of

its preparation on a large scale would lead to a considerable over-production with a consequent rapid fall in prices.

Oil distillers in France and Germany were also consulted regarding the value of sample No. 3. The French firm stated that the oil was of no interest to them, whilst the German firm reported that they distil for themselves all the laurel oil they require. The value of laurel oil in Germany in October 1909 is stated to have been about 10*s*. per lb.

The results of the enquiries made regarding the value of this laurel oil indicate that there would be great difficulty in selling it in this country, and the present demand in Germany appears to be fully met by the existing sources of supply.

"*Mint*" Oil

This sample was received in October 1909. It was described as "oil distilled from *Mentha sylvestris*" and consisted of golden-yellow oil, possessing a sharp, spicy taste and a strong odour recalling that of a mixture of peppermint, spearmint, and pennyroyal oils.

It was examined with the following results:

Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9687
Optical rotation in 100 mm. tube at 20° C.	+ 31° 58′
Saponification value:	
Original oil	24·9
Acetylated oil	175·5
Solubility in alcohol	In 2½ or more volumes of 70 per cent alcohol.

The oil was submitted to several firms of English and Continental distillers, and dealers in essential oils, who all agreed that it would have no commercial value as a peppermint oil. One firm described it as more like lemon-thyme oil than mint oil, and expressed the opinion that it was distilled from a mixture of plants, probably including pennyroyal.

The distinctive features of this oil are its high specific gravity and its strongly dextrorotatory character. In these respects it differs from most peppermint oils and is more like the pennyroyal oils, but the proportion of alcohols present is higher than in the latter oils and the odour is different.

As this oil does not resemble any of the essential oils of commerce, and presents no peculiarity in odour likely to make it useful, it is improbable that it would find a market.

Myrtle Oil

Two samples of myrtle oil from Cyprus were received in October 1909 and March 1910 respectively. Sample No. 1 was described as "Myrtle oil from *Myrtus communis*." Sample No. 2 was labelled "Myrtle oil extracted from leaves of Myrtle collected at Pyego." The former was pale yellow in colour, and the latter pale yellowish-green; both possessed a marked odour somewhat recalling those of rosemary and eucalyptus oils.

The following table shows the results of examination of these oils compared with those of commercial myrtle oil:

	Sample No. 1.	Sample No. 2.	Oil of *M. communis* according to Gildemeister and Hoffmann.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9166	0·9302	0·890 to 0·915
Optical rotation in 100 mm. tube at 20° C.	+ 8° 14′	+8°	+ 10° to + 30°
Saponification value:			
Original oil	25·1	25·2	not recorded
Acetylated oil	61·5	—	"
Solubility in alcohol	In 5 or more volumes of 70 per cent. alcohol.	—	—

The oils were submitted to several firms of merchants dealing in essential oils, from whose reports it appears that there is only a very small sale for myrtle oil in the United Kingdom. It is thought that the only possible use for this Cyprus oil would be as a substitute for rosemary or spike oils, but even this is doubtful, as it is lacking in fragrance as compared with these oils. Moreover the price of these oils was then only about 2*s.* per lb. (April 1910). A German firm reported that this myrtle oil resembled samples from Asia Minor which they had examined but for which no market had been found.

The analytical results recorded above show that the Cyprus myrtle oil has a specific gravity and optical rotation similar to those of the myrtle oils prepared in other countries,

but that it most closely resembles the myrtle oils of Corsica, Asia Minor, and Southern France. Like these oils the saponification values of the original oil and the acetylated oil are relatively low.

About twenty years ago myrtle oil was used, especially in France, for the production of "myrtol," the portion of the oil boiling at 160° C. to 180° C., which was used in medicine. The value of "myrtol" was however subsequently shown to be due to cineole, a substance present in much greater quantity in eucalyptus oil. For this reason the use of "myrtol" declined, and the small demand appears now to be amply met by the small quantities of myrtle oil produced in France and Spain.

PEPPERMINT OIL FROM HONG KONG

Two samples of Chinese peppermint oil from Hong Kong were received in December 1909 and July 1911 respectively.

No. 1.—This consisted of dark red oil, which had a strong peppermint odour. The Chinese oil is stated to be usually colourless or only faintly yellow, so that the discoloration of this sample was probably due to the rusting of the tin in which the oil was forwarded.

No. 2.—A dark brown oil, containing a small quantity of reddish matter in suspension and possessing a pleasant peppermint odour.

The results of the chemical examination of the samples are given in the following table:

	No. 1.	No. 2.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9235	0·9359
Optical rotation in 100 mm. tube at 20° C.	− 44° 8′	− 41° 15′
Total menthol . . . . *per cent.*	61·84	59·8
Free menthol . . . *per cent.*	47·49	43·3
Menthol (as esters) . . *per cent.*	14·35	16·5

Both oils dissolve to a clear solution in 2½ volumes of 70 per cent. alcohol.

The intense dark red colour of the oil would prove an objection to its ready sale, and a portion of sample No. 1 was therefore re-distilled in steam. As thus obtained the oil was almost colourless and possessed a pleasant peppermint odour. The results of the examination of the re-dis-

tilled oil, which are given in the following table, show that its physical and chemical characters were only slightly affected by the re-distillation:

Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$		0·918
Optical rotation in 100 mm. tube at 20° C.		− 44° 40′
Solubility:	Soluble in 2½ volumes of 70 per cent. alcohol.	
Total menthol	*per cent.*	64·24
Free menthol	*per cent.*	50·69
Menthol (as esters)	*per cent.*	13·55

Since the dark red colour of the oil as received was certain to be unacceptable to consumers of peppermint oil in the United Kingdom, it was thought desirable to submit only the re-distilled oil for valuation. The latter was valued at 5*s.* 6*d.* to 6*s.* per lb. in London, with Japanese dementholised oil quoted at 5*s.* 2*d.* to 5*s.* 3*d.* per lb. (September 1910).

This Chinese peppermint oil somewhat resembles in composition the dementholised peppermint oil imported to this country from Japan, as the following comparison shows, but it will be noted that the Chinese is much richer in menthol than even the best specimens of Japanese dementholised oil.

	Present samples.		Dementholised Japanese peppermint oil.
	No. 1.	No. 2.	
Specific gravity at $\frac{15^\circ \text{C.}}{15^\circ \text{C.}}$	0·9235	0·9359	0·895 to 0·905
Optical rotation	− 44° 8′	− 41° 15′	− 20° to − 35°
Total menthol . . *per cent.*	61·84	59·8	43 to 50
Free menthol . . *per cent.*	47·49	43·3	34 to 44
Menthol (as esters) . *per cent.*	14·35	16·5	6 to 11

The value of peppermint oil of a particular class is mainly dependent on the quantity of menthol present in the free state and as "esters." In this respect this Chinese oil is distinctly superior to Japanese dementholised oil, and when it became better known would probably realise higher prices than the latter.

The Superintendent of the Botanical and Forestry Department, Hong Kong, stated in the letter accompanying sample No. 1 that the wholesale price of the oil in Hong Kong is $8.40 (about 14*s.* 9*d.*) per lb., but that the price fluctuates from time to time, whilst sample No. 2 was stated to be worth $9 per lb. in Hong Kong. In view of the valuation of the London dealers quoted above, it does not appear possible that the oil can be exported profitably to this country.

"Ngai Yau" Oil from Hong Kong

This oil, which was labelled "Ngai Yau," was stated to be probably derived from *Artemisia vulgaris*, L., and was said to be distilled in the Kwangsi Province. It was a very dark brown oil, with a sweetish odour, which was slightly camphoraceous but not very penetrating.

The oil was submitted to examination, with the following results:

Specific gravity at 15° C.	0·9390
Optical rotation	The oil was too dark to allow of this determination.
Saponification value	103·3
,, ,, after acetylation	205·87
Solubility in alcohol	The oil gave a clear solution in 1 volume of 90 per cent. alcohol. The addition of further alcohol rendered the solution very turbid.

This oil is stated to be worth $7.20 per lb. in Hong Kong.

A note on the examination by Messrs. Schimmel & Co. of *A. vulgaris* oil from India is given at p. 527.

Lime Leaf Oil from Montserrat

This sample, described as "lime leaf oil," prepared at the Botanic Station, Montserrat, was received in February 1910. It consisted of pale yellow oil, having an odour recalling that of lime oil and "petit grain" oil.

It was examined with the following results :

Specific gravity at $\frac{15° C.}{15° C.}$	0·8772
Optical rotation in 100 mm. tube	+ 38° 17′
Saponification value	27·6
Aldehydes (by sodium bisulphite method) *per cent.*	43
Solubility in alcohol	Not soluble to a clear solution in even 10 volumes of 70 or 80 per cent. alcohol; gave a clear solution with 90 per cent. alcohol up to the addition of 9 volumes when a slight opalescence was produced.

The sample was submitted to a firm of oil distillers, who reported that it was difficult to assign a value to the oil on the results of the analysis alone; they did not consider that it would be of value in perfumery, especially as the odour was not altogether pleasant. In their opinion the oil is only of scientific interest. This oil was first examined by Dr. Francis Watts in 1886 (*Trans. Chem. Soc.* 1886, **49**, 316).

"Petit Grain" Oil from Jamaica

This sample, which was received in August 1909, was stated to be distilled in Jamaica from bitter orange leaves. It consisted of a clear, very pale yellow oil, having an odour slightly different from and less pleasant than that of the "petit grain" oil of commerce. The difference in odour was probably due to the presence of more "free alcohols" than is usually present in "petit grain" oil.

The oil was examined with the following results, which are compared with the figures for commercial oil :

	Present sample.	Commercial "petit grain" oil from leaves, twigs, and immature fruits.	Commercial "petit grain" oil from leaves only.
Specific gravity at 15° C.	0·8884	0·887 to 0·900	0·891 to 0·893
Optical rotation in 100 mm. tube	− 6° 45′	− 1° 22′ to + 3° 43′	− 5° 12′ to − 6° 15′
Esters calculated as linalyl acetate *per cent.*	30·6	38 to 85	51·5 to 69·6
Solubility in 80 per cent. alcohol	Soluble in one or more volumes.	Soluble in 2 volumes.	Soluble in 1 to 1·1 volume.

The oil was somewhat abnormal in composition for a "petit grain" oil. It was found to contain 31·6 per cent. of "free alcohols" and 55·65 per cent. of total alcohols (combined and free).

The sample was too small to permit of commercial valuation.

Pimento Leaf Oil from Jamaica

A sample of this oil, which was obtained from the leaves of *Pimenta officinalis*, Lindl., was received from Jamaica in August 1909. It consisted of clear, light brown oil, with a distinct odour of eugenol and a burning taste.

The oil was examined with the following results, compared with pimento berry oil of commerce.

	Present sample.	Commercial pimento oil (from berries).
Specific gravity at 15° C.	1·026	1·024 to 1·050
Optical rotation in 100 mm. tube	− 5° 30′	slightly lævo-rotatory.
Phenols (chiefly eugenol), *per cent.*	68·6	65
Solubility in alcohol	Soluble in 1·6 vols. of 70 per cent. alcohol.	Gave a clear solution in 2 vols. of 70 per cent. alcohol.

Pimento leaf oil is not a regular article of commerce, and there is very little information on record regarding it. The above figures, however, show that the present sample is about as rich in eugenol as the pimento berry oil of commerce, and it should therefore be readily saleable for the manufacture of eugenol.

The sample was too small for commercial valuation.

Clove Leaf Oil from Zanzibar

This sample was received at the Imperial Institute in April 1909. It consisted of dark brown oil, which possessed the characteristic odour and taste of cloves.

It was examined with the following results:

Specific gravity at 15° C.	1·0652
Optical rotation	The oil was too dark to admit of the determination of this constant.
Eugenol . *per cent.*	85·7
Solubility	The oil was soluble in 1·1 or more volumes of 70 per cent. alcohol.

The sample of oil was not large enough to permit of commercial valuation. The value, however, of clove oil containing 82 to 85 per cent. of eugenol was at the time of the report about 3*s.* 1*d.* per lb. (June 1909), and this clove leaf oil would probably realise a similar price.

The results obtained in the examination of this Zanzibar oil are quite similar to those afforded by a sample of clove leaf oil from Seychelles examined in 1907 (see this BULLETIN, 1908, **6**, 111).

"GORLI" SEED FROM SIERRA LEONE

Two samples of seeds of the "Gorli" plant were received from Sierra Leone in 1908. Herbarium specimens of the plant were subsequently received, and these were identified at the Royal Botanic Gardens, Kew, as *Oncoba echinata*, Oliver. The plant is stated to grow fairly abundantly in the Yorney district and at Gbatema in Sierra Leone, but only in the few remaining patches of high forest, where it would be difficult, if not impossible, to collect large quantities of the seed.

The seeds were of rather irregular shape, from $\frac{1}{4}$ to $\frac{3}{8}$ in. long and $\frac{1}{8}$ to $\frac{3}{16}$ in. wide at the broadest part. The average weight of a single seed was 0·046 gram. The seeds possessed a stiff, brown seed-coat. Internally they were white, waxy in appearance, and soft, but they did not yield visible oil when squeezed with a knife. They possessed a bland, oleaginous taste, but when chewed left a faint peculiar after-taste. The second sample of seeds had a somewhat mouldy odour.

The seeds on analysis gave the following percentage results:

	No. 1.	No. 2.
Moisture	5·8	5·8
Fat	46·6	46·6
Crude proteins	17·5	18·1
Consisting of:		
True proteins	11·3	10·2
Other nitrogenous substances	6·2	7·9
Starch, etc. (*by difference*)	11·8	12·1
Crude fibre	15·6	14·7
Ash	2·7	2·7

The fat was hard, white, and crystalline, and possessed a peculiar characteristic odour. The results of its examination were as follows:

	Fat from sample No. 1.	Fat from sample No. 2.
Specific gravity at 15·5° C.	0·898	0·896
Acid value	4·5	22·4
Saponification value	192·4	193·9
Iodine value . . . *per cent.*	99·7	96·8
Titer test	57·8° C.	57·8° C.
Hehner value	96·5	96·5
Reichert-Meissl value	*nil*	*nil*
Unsaponifiable matter . *per cent.*	1·6	1·3

The fat had not a definite melting point, but gradually liquefied above 35° C., and was completely melted at 45° C.

The higher acid value of the fat from sample No. 2 and the slight variations of the other constants from those of No. 1 were probably due to the fact that the seeds of No. 2 were somewhat mouldy.

The fat yielded a hard soap of satisfactory appearance but possessing the persistent odour of the fat itself.

The fat obtained from these seeds has been further examined by Dr. Ernest Goulding and Mr. Noel C. Akers, of the Scientific and Technical Department, Imperial Institute, and the results have been recently communicated to the Chemical Society of London (*Proc. Chem. Soc.* 1913, **29**, 197).

The fatty acids obtained by hydrolysing the fat had an iodine value 105·1, and specific rotation $[\alpha]_D^{18°}$ + 52·5°, and consisted of a mixture of a crystalline solid and a liquid. The former, after purification, was obtained in the form of thin, lustrous plates, and was identified as chaulmoogric acid, a substance first obtained by Power and Gornall (*Journ. Chem. Soc.* 1904, **85**, 846) from the Indian product "chaulmoogra oil."

The liquid portion of the fatty acids, although saturated with chaulmoogric acid, gave an iodine value 122, showing that the liquid acids are highly unsaturated; it darkened rapidly on exposure to the air.

The mixed fatty acids consisted approximately of chaulmoogric acid, 87·5 per cent., and liquid acids, 12·5 per cent.

The seeds of the Gorli plant could probably be employed as a source of fat, which might be of use for soap or candle manufacture, but no definite opinion can be expressed on this point in the absence of technical trials. The fat would not be suitable for edible use on account of the large proportion of chaulmoogric acid it contains, fats containing this acid having recently been proved to possess toxic properties (see this BULLETIN, 1911, **9**, 406).

SPECIAL ARTICLES

THE "WOOD-OIL" TREES OF CHINA AND JAPAN

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ALEURITES, a small genus of about six species belonging to the Euphorbiaceæ, all trees and natives of extreme eastern Asia and Malaysia, is of considerable economic importance, owing to the fact that the seeds of all the species are rich in useful fixed oils. The products of these trees have, in a limited way, been known for a very long time, but in the near future they are destined to occupy a much more important place in Western arts and commerce than heretofore. In particular does this apply to the so-called "wood-oils" of China and Japan. During the past decade there has been an increasing demand for these oils in the markets of Europe and North America. The exports from China have increased enormously, and prices have risen considerably. In a densely populated country like China, where the food of the people is all supplied from within, and where every inland district is compelled, owing to difficulties of intercommunication, to support its own inhabitants, every available square yard of land is tilled for the production of foodstuffs and other crops indispensable to the life of the people. Plants yielding economic products useful in the arts and in general commerce can of necessity be allowed to occupy only such land

as it is impossible to cultivate otherwise. These facts serve to demonstrate that until vast changes take place in China in the conditions of the life of the people and of intercommunication, there must be an obvious limit to the supply of such products for export purposes. If, therefore, the increasing demand for wood-oils in Western markets is to be adequately met, it is imperative that the source of supply be extended. Within the British Empire can be found vast tracts of country little suited to general agriculture or to the cultivation of more exacting economic plants, yet admirably adapted for the culture of Chinese Wood-oil trees. In warm-temperate, rocky parts of Australia, South Africa, the East Africa Protectorate, India, and elsewhere, the attention of agricultural departments might advantageously be directed towards these trees.

Their cultural requirements are of the simplest. The growth is rapid, and the trees commence to bear fruit in four or five years after the seed is sown. The trees are of relatively low stature, with wide-spreading heads, and are apparently indifferent to the nature of the soil. They are exceedingly ornamental when in flower, and they fruit very freely. These qualities, together with an assured market for the oil in increasing quantities, should be sufficient inducement to warrant their experimental culture being undertaken in suitable parts of the British Empire.

The Department of Agriculture of the United States has been experimenting with the most important of these Wood-oil trees (*Aleurites Fordii*) since 1905, and from a *Circular* on the subject (*Circ.* No. 108, *Bur. Pl. Indust.*, *U.S. Dept. Agric.*, April 1913) it is evident that a very considerable measure of success has been attained. It has been shown that this tree can be successfully grown in parts of the United States; also that it fruits freely, and that there is no reason to believe that the oil obtained is of other than equal value with that produced in China. Wood-oil trees have fruited well in South Carolina, Alabama, Louisiana, Mississippi, Georgia, Texas, California, and Florida. In the last-named State, one tree, raised from seed sent from Hankow, China, in 1905, bore 410 fruits in 1911 and 852

fruits in 1912, approximately one and two bushels respectively. It has not been injured by a temperature of 14° F.[1] "The tree has stood a temperature as low as 4° F. at Clemson College, South Carolina, without injury, except the loss of a few lateral branches, and is slow to start into growth even when subjected to a temperature of 80° F. It is therefore not so liable to be injured when this temperature is immediately followed by a drop to 18° F." The same *Circular* states further that the imports of this oil into the United States in 1911 amounted to five million gallons, to produce which 40,000 acres of trees would be required, planted 20 ft. by 20 ft., that is, 108 trees to the acre. It concludes by stating that the Department of Agriculture will have, in 1914, a limited number of one-year-old trees for distribution to *bona-fide* experimenters. "Experiments with single trees have been made, and what is now desired is the creation of acre plantations in the hands of private individuals."

It is the purpose of this article to give an account of the Wood-oil trees of the Far East, more especially of the particular species which yields fully nine-tenths of the oil used in and exported from that region.

In China, two distinct species of Aleurites (*A. montana* Wils., and *A. Fordii* Hemsl.), each occupying for the most part distinct geographical areas, yield the wood-oils of commerce. In southern Japan a third species (*A. cordata* R. Br.), occurs, but the oil does not figure as an article of export to western countries. These three species from very early times have been almost hopelessly confused. The confusion began with Lamarck (*Encycl. Méth. Bot.* ii. 329 (1786)), who described the flowers, leaves, and shoots of *A. cordata* and the fruit of *A. montana* under the name of *Dryandra oleifera*. In 1824, Adrien de Jussieu (*Euphorb. Gen. Tent.* 38, t. 11, fig. 35), described and figured the flowers of *A. cordata* and the fruit of *A. Fordii* under the name of *Elæococca verrucosa*. Since the above dates, many names have been applied to these

[1] In that part of China where this tree luxuriates, the temperature seldom falls below 25° F., and the tree is not in any sense of the term hardy in cool-temperate regions.

Chinese and Japanese trees, and various botanists, Adrien de Jussieu himself, for example, considered that two species were involved, but not until 1906, when Hemsley (in *Hooker's Icon.* xxix, tt. 2801, 2802) established *A. Fordii*, was this clearly defined. Unfortunately, owing doubtless to lack of sufficient material, Hemsley failed to distinguish the Japanese and southern Chinese trees as distinct species, and, therefore, while correcting Adrien de Jussieu's mistake, he unwittingly perpetuated that of Lamarck.

As will be shown later (pp. 445, 456), these three species possess very distinctive characteristics, especially in the fruit, yet in the absence of complete material it is easy to confuse them. The oil from the seeds of any of the three species has been indiscriminately known to foreigners trading with China as "wood-oil" from the earliest times, and the explanation of this is not far to seek. The first sea-trade between Europe and China commenced in A.D. 1516, when Captain Raphael Pestrello, a Portuguese, visited Canton. In 1517, a small Portuguese fleet, under the command of Ferdinand Andrade, anchored near Maçao. The commander was well received by the Chinese, and allowed to proceed with two ships to Canton, where he obtained permission to trade. Other expeditions followed, and in 1537 the Portuguese had established three trading stations in the gulf of the Canton river. Of these, Maçao, on account of its favourable location, was the most important, and the others were in time abandoned. For more than three centuries the trade between the Occident and China was carried on principally with Maçao, Canton, and the near-by ports in south-east China. The names assigned to various native products by foreign traders in these early days were afterwards applied to the same or similar products emanating from northern, central, and western China. Hence the name wood-oil ("mu-yu"), strictly applied by the Chinese to the oil expressed from the seeds of *A. montana*[1] in south-eastern China, was in time extended by foreigners to include a similar product obtained from the Yangtze Valley and derived from

[1] The ripe fruit of this tree is hard and woody, and probably this is the origin of the name "Wood-oil tree" ("Mu-yu shu").

A. Fordii, which the Chinese themselves designate tung-oil[1] ("tung-yu").

"*Mu-yu shu.*"—As indicated earlier in this article (p. 443) the first mention of the Mu-yu shu (literally, Wood-oil tree), *A. montana* Wils., occurs in Lamarck's *Encycl. Méth. Bot.*, where, under the name of *Dryandra oleifera*, the fruit of this tree is described, in conjunction with the flowers and foliage of *Aleurites cordata* R. Br.. The major part of the description refers to this latter tree, and therefore the specific name cannot stand, yet Lamarck's general remarks leave no doubt but that he had the Chinese rather than the Japanese tree in mind. He states that it is called "Mou-yeou" by the Chinese and that it was cultivated in the Jardin du Roi à l'Isle de France. The Jesuit missionary, Loureiro, a Portuguese, established himself at Canton in 1779, and for three years investigated the flora of that region. He secured specimens of the Mu-yu shu, and in his *Fl. Cochinch.* 587 (1790) describes it as *Vernicia montana*, and his specific name, being the oldest valid name, must stand. Subsequent authors gave other names to this tree, and several of them, notably Mueller Arg. (in De Candolle's *Prodr.* xv. pt. 2, 724 (1866)), continued the confusion begun by Lamarck (*loc. cit.*).

As a cultivated tree, *Aleurites montana* occurs in the sub-tropical parts of south-eastern China from the province of Fokien southward to Tonking, and is also undoubtedly a native of these regions. I have seen herbarium specimens of this tree from Fokien and from the island of Hainan, but have only seen living trees on the island of Hong Kong, and therefore am not in a position to give intimate details concerning its cultivation. It, without question, requires a sub-tropical climate and a more abundant rainfall than its more northern relative, *A. Fordii.* In the central parts of the Fokien province, both Mu-yu and Tung-yu trees occur, according to Dunn (*Report on the Bot. and For. Dept. Hong Kong*, 1905, 117), and are known colloquially as "Hwa-tung"

[1] The name "Tung" is applied in China to several widely distinct trees having large, heart-shaped leaves, among them Paulownia, of which four or five species occur. In Japan "Giri" ("Kiri") is the name of *Paulownia tomentosa* Steudel, and it is worthy of note that one of the colloquial names for *Aleurites cordata* R.Br., is "Abura-giri"—"Oil-giri."

and "Guong-tung" respectively. "The Hwa-tung," to quote Dunn, "is the most valued because all the flowers of the majority of the trees produce fruits from which the oil is made, while in the second kind a few flowers only in each cluster are perfect, quite 80 per cent. being male flowers." This statement is not borne out by specimens before me, including some collected in Fokien by Dunn. The inflorescences might almost be classed into male and female, but there is nothing to indicate whether or not they came from the same or different trees. From the herbarium material, one might reasonably assume that the tree was nearly diœcious, yet in all probability it is monœcious, as in other species of the family, but with a strong tendency to have the male and female flowers collected into different inflorescences on the same tree.

The Mu-yu tree in size, habit, foliage, and general appearance (but not in its flowers and fruit) closely resembles the Tung-yu tree (*A. Fordii* Hemsl.). The flowers are borne in a terminal corymb or a raceme on shoots of the current season's growth after the leaves have fully expanded. The "male" inflorescence is many-flowered, much-branched, corymbose, 15–20 cm. long and 20–30 cm. (1 cm.=0·3937 in.) broad. The "female" inflorescence is relatively few-flowered, racemose, and 8–12 cm. long. The fruit (Plate XIII., Fig. 1) is markedly distinct, being egg-shaped, 5–6 cm. long, 4–4·5 cm. wide, pointed at the summit and flattened at the base, with three longitudinal and many transverse, much-raised ridges; the interior part of the fruit (mesocarp) is thick and woody and encloses (usually) three compressed, broadly obovoid seeds, each about 3 cm. long by 2·5 cm. broad, and warty on the outside. When ripe the fruit opens from the base upward into three parts and the seeds can then be readily extracted. Since the fruit is comparatively thick and quite woody, it is not easily retted by fermentation, as is the case in that of the Tung-yu tree.

As will be shown later, the exports of oil from this tree are small, and it is quite impossible to cite chemical analyses that apply solely to the mu-yu, the product of *A. montana*. In all probability mu-yu has been investigated

by chemists, but owing to the botanical confusion that has existed down to the present it has not been clearly distinguished from the tung-yu or from the Japanese wood-oil. It is therefore very desirable that both the kernels which yield this mu-yu and the commercial product itself be examined by chemists, and its constants, etc., definitely established. In order to avoid any possible error, a sample of the fruit should be obtained and the seeds extracted in the laboratory.

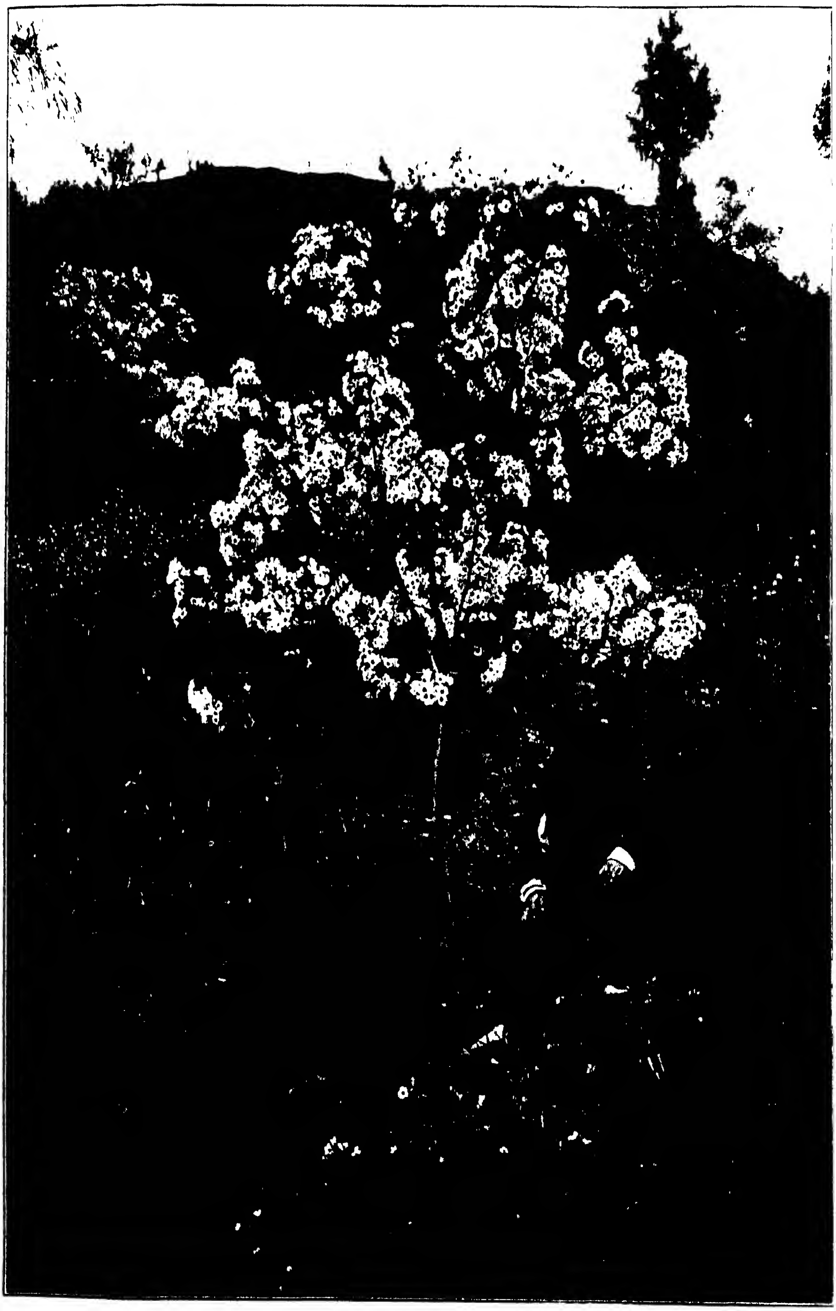
Tung-yu shu.—The first reference in European literature to the Tung-yu shu (literally Tung-oil tree), *A. Fordii* Hemsl., occurs in Adrien de Jussieu's *Euphorb. Gen. Tent.* p. 38, t. 11, fig. 35 (1824), where, under the name of *Elæococca verrucosa*, the fruit and seed are figured, together with the flowers of the Japanese *Aleurites cordata* R. Br.. This confusion remained until Hemsley (in *Hooker's Icon.* xxix. tt. 2801, 2802 (1906)), established the Tung-yu shu as a distinct species under the name of *A. Fordii*. This species is the most hardy member of its family. It is much more widely distributed in China than the allied species *A. montana*, and furnishes fully nine-tenths of the wood-oil used in and exported from China. The Tung-yu shu is unquestionably the tree whose culture should be experimentally undertaken in the parts of the British Empire already indicated. In procuring seeds for this purpose, it must be borne in mind that, like all seeds rich in oils or fats, they soon lose their power of germination if exposed to sunlight and air. The ripe seeds keep quite well in the fruit husks, and it is advisable to obtain them for planting in this form. If the ripe fruits are dried in the sun for two or three days and then packed in sacks or barrels, the seeds will travel well and retain their germinating power for three or four months. If the seeds are removed from the fruit they must be packed in thin layers, in boxes of soil. The soil used should contain sufficient moisture to cause the particles of earth to cohere when firmly squeezed in the hand, but not enough to prevent them falling asunder into a powder when the mass is dropped from a height of 2 ft. or so to the bottom of a box or on a hard floor. Any attempt to transport the shelled seeds loose in boxes or

bags, over distances long enough to occupy a month or more in transit, especially through the tropics, will end in failure.

The Tung-oil tree occurs in all the warm-temperate parts of China, but more especially those within the watershed of the Yangtze River. It also occurs in the provinces of Fokien and Yunnan. Its centre of distribution is undoubtedly north-west Hunan and Kweichou, and the region contiguous to the Yangtze River, in western Hupeh and Szechuan, from the city of Ichang westward to that of Chungking: thereabouts, up to 800 metres altitude (1 metre = 3·27 ft.), a traveller is never out of sight of groves of this tree, and in April, when in flower, it is a most striking feature in the landscape. The tree appears to have no strong predilection in the matter of soil, and grows equally well on conglomerate, hard limestone, sandstone, or sandy clay. It is essentially a hill-side tree, thriving in the most rocky situations and in the poorest of soils where there is a minimum rainfall of 70 cm.; it will also withstand drought and a few degrees of frost. At Ichang, where this tree luxuriates, the climate is one of extremes. The summer is tropical, the temperature in June, July, and August ranging between 90° and 110° F. in the shade. The winter is cold, snow often lying on the ground for days, but the temperature seldom falls as low as 28° F. In the mountains, at 800 metres altitude, the summer is somewhat cooler and the temperature may fall to 24° F. and occasionally even as low as 20° F. The annual rainfall at Ichang, according to the Maritime Customs' statistics, averages about 75 cm., most of which is precipitated in the months of April, July, and August.

A quick-growing, short-lived tree, *A. Fordii* seldom exceeds 10 metres in height, and averages less. It has a much-branched, flat-topped or rounded head, 5 to 10 metres or more through, and is highly ornamental either in flower or foliage (Plates IX. and X.). The bark is smooth and pale grey: the wood white, soft, and of no value save as fuel. The flowers are produced in April before the leaves unfold, and are borne in numerous, terminal and axillary, few-flowered cymose corymbs, which

PLATE IX.



Aleurites Fordii, 2 metres tall. Banks of Yangtze River, April 6, 1908.

collectively form, at the end of every shoot, a loose, rounded truss of flowers. These flowers are 2·5–4 cm. across, white, stained with pink, and have yellow markings, more especially near the base; the central, terminal flower of each cyme is female, the others are usually male. The leaves are deciduous, and when full grown, dark, shining green, broadly ovate, long-pointed, and heart-shaped at base; the blade is 10 to 20 cm., or more, long and broad; the leaf stalks 15 cm. or more long; on young trees and on very vigorous, usually sterile shoots, the leaves are three-lobed. The fruit (Plate XII., Fig. 2; Plate XIII., Fig. 2) is apple-like, green passing to dull brown when ripe, flattened round or somewhat turbinate, 4 to 5 cm. long and broad, with a short point at the summit, somewhat narrowed to the foot-stalk, and perfectly smooth on the outside. The fibrous "flesh" is 3–4 mm. thick, and encloses three to five, rarely more, compressed, broadly obovoid seeds, each 2–2·5 cm. long and broad, and very slightly ridged and warty on the outside (Plate XII., Fig. 2). Both fruit and seed are poisonous to man, causing severe vomiting and purging.

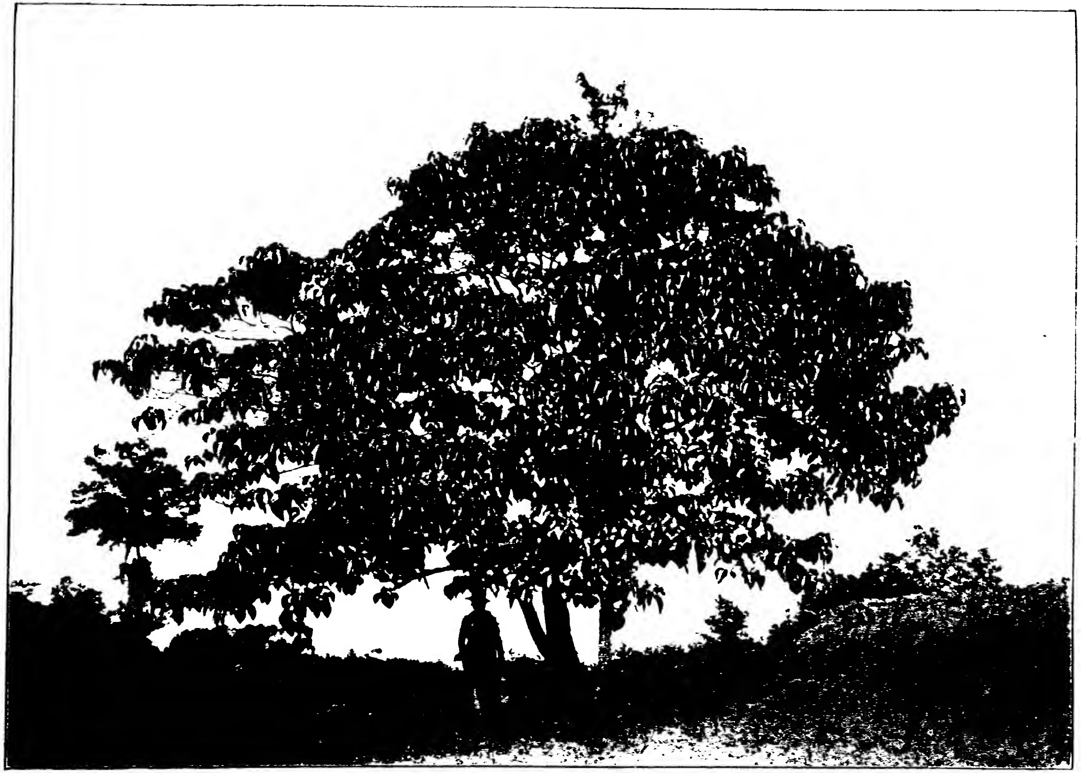
The fruit ripens in September and October, and breaks naturally from the base upward into three parts when ripe and dry, but it is invariably gathered before this stage, and collected into heaps which are covered with straw and grass. Fermentation sets in and quickly disposes of the thin "flesh" of the fruit, after which the seeds are easily removed. The low stature of the trees simplifies the gathering of the fruits, which is accomplished by knocking them off with poles. The yield per tree varies from one to five or more bushels, according to size. As mentioned earlier, there are no systematically cultivated orchards of this tree in China. It is planted on rocky hill-sides, waste places and road-sides, being allowed to occupy only sites where farming is impossible. In such places, the trees may be few and scattered, or they may form dense groves (Plate XI.), but any one attempting the cultivation of these trees as a business is recommended to plant them not less than 20 ft. apart each way.

Extraction and Uses of Wood-oils in China

The process adopted by the Chinese for extracting the oil is very simple. The seeds are first crushed in a circular trough beneath a heavy stone wheel worked by horse- or ox-power. The comminuted mass is then partially roasted in a shallow pan, after which it is placed in a wooden vat, fitted with a wicker bottom, and thoroughly steamed over a cauldron of boiling water. Next, with the aid of an iron ring and straw, it is made into circular cakes about 45 cm. in diameter and 10 cm. thick. These cakes are arranged edgeways in a large wooden press (Plate XII., Fig. 1) which accommodates about a dozen, and when full, pressure is exerted by driving in one wedge after another, thereby crushing out the brown, somewhat watery and heavy-smelling oil, which falls into a vat below. The yield is about 40 per cent. by weight of the kernels; the refuse cakes are used on the fields as manure. This tung-oil is packed in wooden tubs or bamboo baskets, and is ready for export. In Hupeh I have frequently seen the fruit of the "Lacquer-varnish tree" (*Rhus vernicifiua*, Stokes) (this Bulletin, viii. 32, (1910)) mixed and ground up together with the tung-oil seeds. The oil expressed from the mixture of the two is used as an illuminant, but is very dirty, producing much smoke and very little light. The oil from the fruit of the Lacquer-varnish tree is made into candles and used by the Chinese peasants in mountainous districts. Of late years, since the increased demand for tung-oil as an article of export, bean-oil, obtained from the Soy Bean, has become a recognised adulterant, and sesamum-oil is also used. As the demand increases other oils will doubtless be thus illegitimately employed, including that obtained from the fruit of the Lacquer-varnish tree.

Uses.—In China the uses of mu-yu and tung-yu are manifold. They are the chief paint-oils of the country, and are largely employed as varnish, as waterproofing material, as ingredients in concrete, as medicine, etc. The Chinese do not paint their boats, they oil them, and the myriads of such craft plying on the Yangtze and other rivers of

PLATE X.



China, and up and down the coasts of that country, are all coated, and the upper-works kept waterproof, with these oils. For how many hundreds of years the Chinese have known and employed these wood-oils it is impossible to compute. Marco Polo[1] says "They take some lime and chopped hemp, and these they knead together with a certain *wood-oil*; and when the three are thoroughly amalgamated they hold like any glue, and with this mixture they do pay their ships." What the famous Venetian observed in the latter end of the thirteenth century obtains to-day. The boats in China are still caulked with the above material, and probably have been since before the dawn of the Christian era.

The tung-yu is much more plentiful and is consequently more widely used in China than the mu-yu; it is also the oil of which I have intimate knowledge, and the remarks which follow apply strictly to this oil. The crude tung-yu, after being boiled for an hour, becomes a greyish-white, syrupy oil ("pei-yu" or white oil) and is used for mixing with paints or lacquer-varnish, and as a varnish for boats, furniture, and general woodwork. The method of applying it as a varnish is very simple. The surface of the wood is smoothed with a plane or some other sharp-edged tool, and the pei-yu is rubbed on with a piece of rag, a dry and preferably a sunny day being chosen for the purpose. Two or three separate coatings are applied, each being allowed to dry before another is put on. The drying process only occupies a few hours. When finished, such varnished woodwork glistens in the sun like a mirror. Pei-yu is added to lacquer-varnish for the double purpose of lightening the colour and causing it to dry more quickly. Four to eight ounces of pei-yu added to 16 oz. of crude lacquer-varnish, which is black, will produce a brown varnish, which dries rapidly even in moderately dry, hot weather. The more pei-yu added the paler the varnish, and the more quickly it dries. This mixture is commonly employed on the upper works of foreign ships engaged in the coast trade of China. The colour is much more serviceable than that of lacquer-varnish alone; moreover,

[1] *The Book of Ser Marco Polo, the Venetian*, 2nd. ed., ii. 232 (1875), by Col. Yule.

the latter is irritant and poisonous, and will only dry outside in cloudy weather, when the atmosphere is surcharged with moisture. Pei-yu is also one of the constituents of red and of yellow lacquer-varnish. A chocolate-coloured pei-yu is obtained by allowing the oil to mature in old lacquer-varnish tubs.

Crude tung-yu, boiled for two hours with the addition of certain mineral substances, produces a yellowish-grey, viscid varnish known as "kuang-yu." I am not sure of the nature of the mineral substances. One, called "tu-tzu," consists of nodules of earth, grey coloured outside and dark brown within; the other, known as "to-shên," is powdered quartz, impregnated with a substance resembling iron pyrites. To 100 catties (1 catty equals 1⅓ lb.) of crude tung-yu is added half a catty of tu-tzu and 8 catties of to-shên. Kuang-yu is applied by a brush to silk gauzes and pongees to make them waterproof. It dries very quickly on exposure to the air, and is kept carefully covered with paper to prevent drying before application.

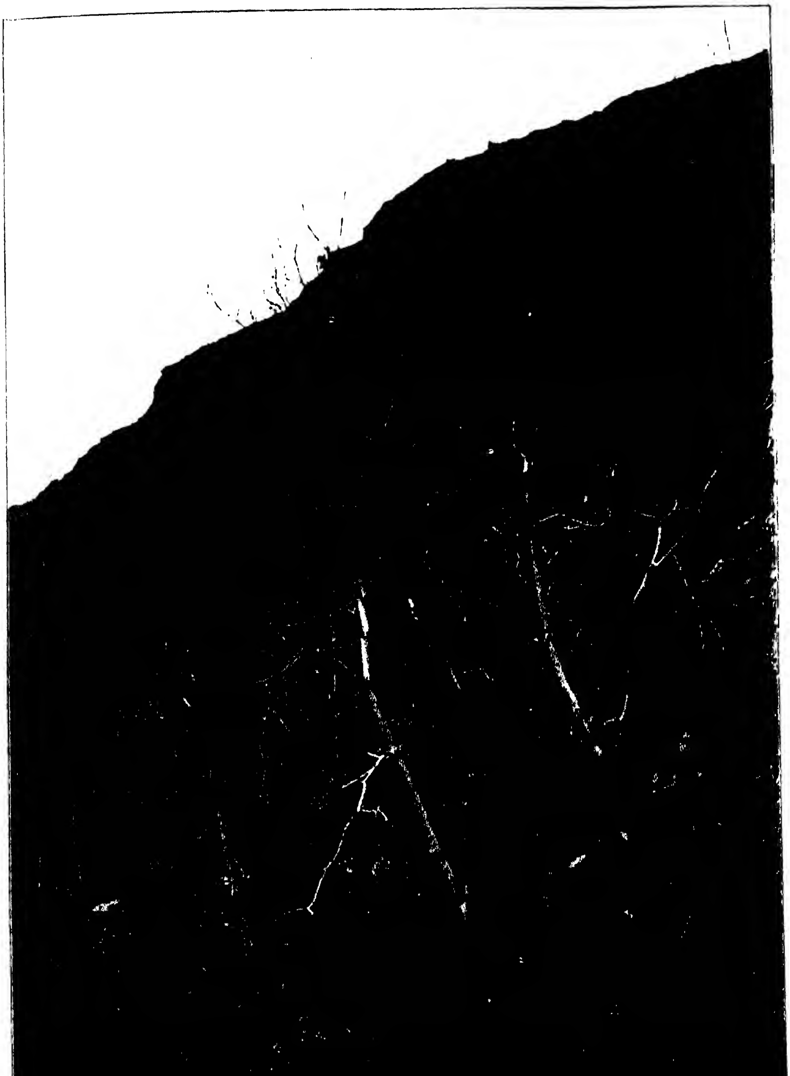
As an illuminant tung-yu is of little value, being exceedingly dirty, and is only used by the peasants in the more remote parts of central China. The lamp-black produced by burning the oil, or the fruit, is a most important ingredient in the manufacture of Chinese ink.

Exports of Wood-oils

The only statistics available on the trade of China are those published by the Maritime Customs, and these only cover the returns for the few treaty ports, and even of these have no concern with the vast volume of trade passing through the Native Customs. The Maritime Customs trade returns are very condensed, and various oils are frequently grouped under one heading, and it is only in the returns of one or two ports that wood-oils appear as a separate item. Hankow is the great trade entrepôt of central China, and monopolises the export of many products, including that of tung-oil. The export from Hankow of this oil in 1900 was 330,228 piculs,[1] valued

[1] By the Trade Regulations annexed to the British Treaty of 1858, the "picul of 100 catties is held to be equal to 133⅓ lb. avoird.," giving a catty of 1⅓ lb. avoird., and a tael of 1⅓ oz. avoird., equal to 583·3 grains.

PLATE XI.



Grove of trees of *Aleurites Fordii*, 5 to 6 metres tall. Banks of Yangtze River, January 5, 1909.

at 2,559,344 Haikwan taels[1]; and in 1910, 756,958 piculs, worth 6,449,421 Haikwan taels.

This product, apart from adulteration with other oils (see p. 450), is all obtained from *Aleurites Fordii.*

Wood-oils figure as an article of export from Wuchow, a treaty port west of Canton, on the West river. The export in 1900 was 24,469 piculs, valued at 146,813 Haikwan taels; and in 1910, 52,106 piculs, value not returned.

This product, wholly or in part, not reckoning adulterants as mentioned above, is presumably obtained from *A. montana* (Mu-yu shu). However, it is very probable that a certain amount of tung-oil is also concerned in this export. On this point information is lacking.

From Kongmoon, a port in the Canton delta, a small export of wood-oil is made, and this product is without doubt obtained from *A. montana.*

From none of the other coast or riverine treaty ports[2] do wood-oils figure as an export in the Maritime Customs Trade Returns. Dunn (*Report Bot. For. Dept. Hong Kong,* 1905) states that wood-oil is abundantly produced in the province of Fokien, and is one of the chief products brought down the Min River from the western part of the province. After mentioning that he found two species of Wood-oil trees (*A. montana* and *A. Fordii*) growing together near Yenping, and giving a brief account of these trees and the method of obtaining the oil, Dunn concludes by stating that "it does not appear to have been suspected that wood-oil was a mixture of the products of two species." These observations have local value and significance only. Wood-oils do not figure as an article of export in the Maritime Customs Trade Returns for Foochow, Amoy, or Santuao, the only treaty ports of the province of Fokien. An enormous quantity of these wood-oils is used in China, and it figures as a native import of considerable importance in the trade returns above cited for several

[1] Haikwan, or "Customs" tael, is the currency in which duties are levied by the Chinese Maritime Customs, but it is purely a money of account, and not an existing currency. It is the equivalent of 584·85 grains of pure silver, and its sterling value is dependent on the market price of silver.

[2] Shanghai returns are of no value in this trade, since wood-oil is simply a re-export from Shanghai, having been brought down from Hankow.

treaty ports on the coast. From all sources of information available, it is evident that more than nine-tenths of the wood-oil of commerce is exported from Hankow, and that this oil is obtained from but one species of Aleurites, namely, *A. Fordii*, the Tung-yu shu of the Chinese.

Composition of Tung-oil

Although tung-oil has been used for many centuries in China, its introduction into European and American commerce is comparatively recent. When introduced into these countries the peculiar properties of the oil at first prevented its adoption by manufacturers of paints and varnishes, but means of utilising the oil for many purposes have now been discovered, and it is at the present time in good demand at a price higher than that paid for linseed oil.

Tung-oil, as it appears in European commerce, is a yellowish-brown or brown viscous oil, with a peculiar, characteristic smell. The constants of the oil have been until recently a matter of some doubt, investigators in the past having quoted very variable figures. These differences were probably due to such causes as (1) the examination of adulterated samples, (2) differences in the methods of preparing the oil, (3) alteration of the oil during storage, and (4) confusion between Japanese and Chinese wood-oils. The recent researches of Kreikenbaum (*Jour. Ind. Eng. Chem.* ii. 205 (1910)), Chapman (*Analyst*, xxxvii. 543 (1912)), Hoepfner and Burmeister (*Chem. Zeit.* xxxvii. 18, 39 (1913)), and others have, however, afforded accurate information as to the constants of tung-oil as it appears in commerce. The following figures were obtained by Chapman (*loc. cit.*) from the examination of seventeen samples of oil from Hankow, to which are added, for purposes of comparison, the results obtained with oil extracted from kernels of *A. Fordii* at the Imperial Institute (this Bulletin, v. 134 (1907)); these kernels contained 58·3 per cent. of oil.

	Maximum.	Minimum.	Mean.	Oil of *A. Fordii*.
Specific gravity at $\frac{15° C.}{15° C.}$	0·9440	0·9406	0·9425	0·940
Saponification value . . .	196·6	192·0	194·2	191·8
Iodine value . . . *per cent.*	176·2	166·4	170·6	166·7
Refractive index at 20° C. . . .	1·5207	1·5150	1·5179	—
Viscosity by Redwood viscosimeter at 15·5° C. . . . *seconds*	2,178	1,605	1,850	—

PLATE XII.

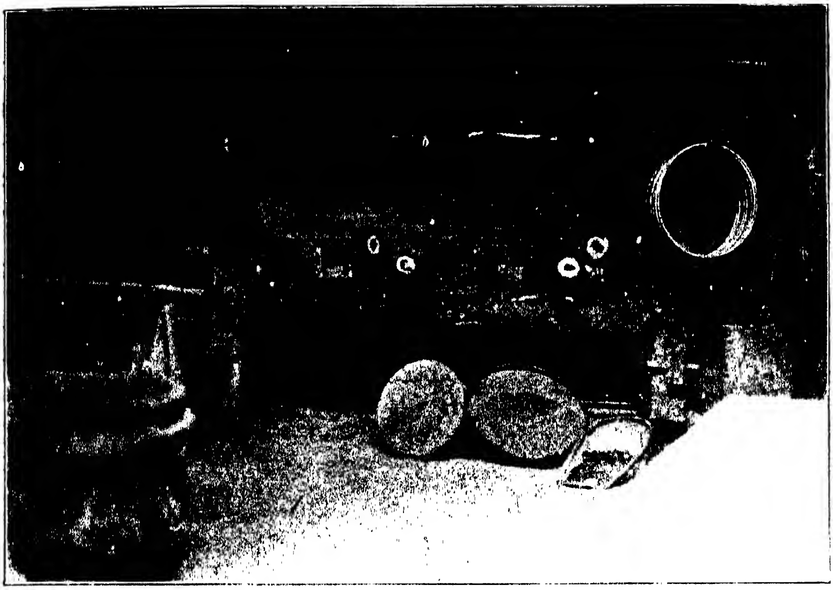


FIG. 1.—Wedge press used for extracting wood-oil. Basket of seeds and oil cake in foreground.

FIG. 2.—Fruit and seeds of *Aleurites Fordii*. Natural size.

The above figures show that tung-oil is characterised by (1) a specific gravity higher than that of almost any vegetable oil, except castor and tallow-seed oils, (2) a refractive index considerably higher than that of any known vegetable oil, and (3) a high viscosity. The most characteristic property of the oil is its conversion into a firm, gelatinous mass when heated to a temperature of 250° C. or over, for a short time; this change appears to be due to polymerisation and not to the absorption of oxygen. The polymerised oil does not melt on further heating, and is insoluble in the usual solvents for oils, such as ether, etc. This property of forming a gelatinous mass on heating is the basis of a number of tests, in which the oil is heated under stated conditions for a certain time. Under these conditions genuine tung-oil should yield a firm jelly, which will crumble readily in the fingers, and is not sticky. Samples adulterated with other oils yield, on the contrary, a soft, sticky jelly, or even remain liquid, if large quantities of adulterants have been added.

Chinese wood-oils are said to consist chiefly of glycerides of oleic and elæomargaric acid (Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, ii. 62 (1909)), and in tung-oil the power of polymerising may be due to the presence of the latter constituent, the properties of which have not been investigated very completely up to the present time.

Uses of Tung-oil in Europe and America

Although tung-oil possesses a drying power even higher than that of linseed oil it does not yield a clear, bright, transparent film like that afforded by linseed oil, the film produced by raw tung-oil being opaque, and having a matt and sometimes wrinkled surface. This fact, and its polymerisation on heating, render the raw oil unsuited for use in paints and varnishes, and appear to have prevented its adoption when first introduced into Europe and America. There can be no doubt, however, that these difficulties have been overcome, as large quantities of tung-oil are now used by paint and varnish makers, especially in the United States, although manufacturers

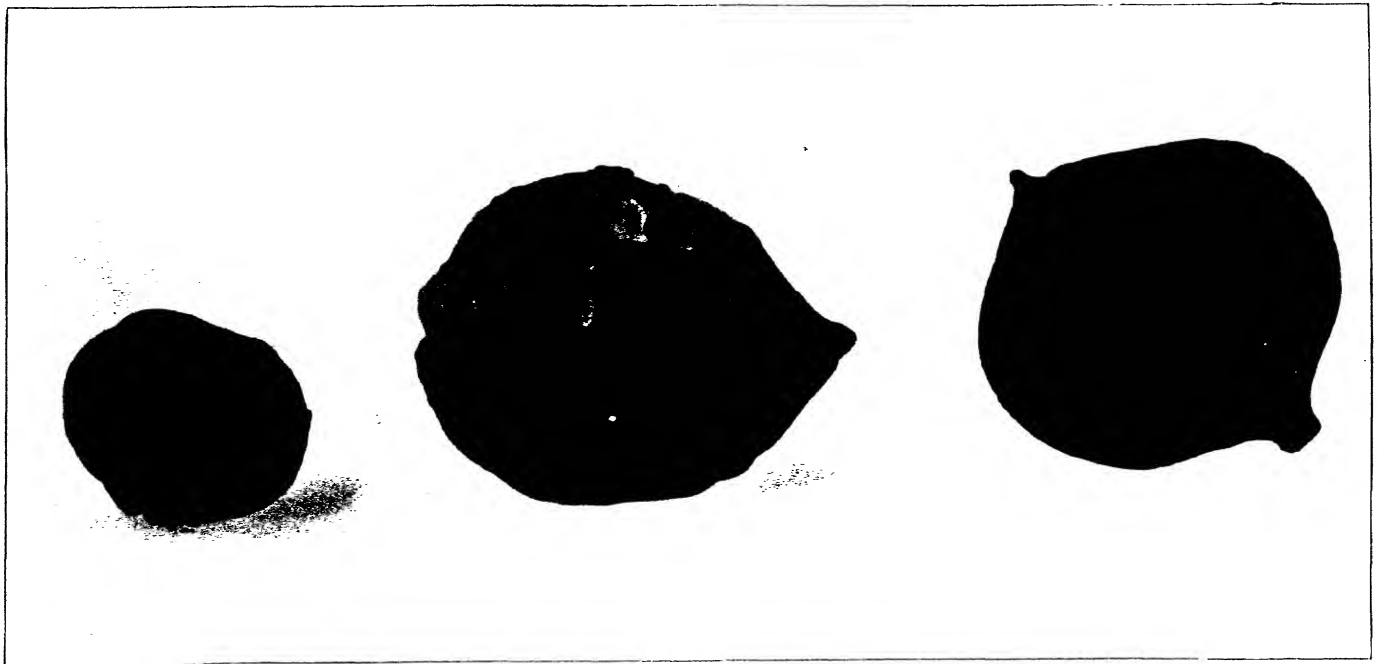
are distinctly reticent as to their methods of using the oil. According to Bottler (*Varnish-Making*, English translation by Sabin, 1912, 49), the raw tung-oil is heated for two hours at 170° C., and then allowed to stand and clear. The cleared oil is next heated to 180° C. for one hour, when it thickens somewhat; it is then allowed to cool to 130° C., and 2 per cent. of litharge is added. After this treatment the oil can be thinned with oil of turpentine or other solvent, and used as required for paints or varnishes. Although the gelatinous, polymerised oil is insoluble in the usual solvents, such as oil of turpentine, it can be melted by adding an equal amount of poppy-seed oil or walnut oil and heating: the resulting soft mass is soluble in solvents, and can be used for varnish making. (*Handbuch der Lack und Firnis-Industrie*, Seeligmann und Zieke, p. 319 (1910)).

The principal uses of tung-oil are in the paint and varnish industry; the oil is also used for the preparation of paint "driers," consisting of compounds of the fatty acids of the oil with such metals as lead or manganese. These compounds are known as "tungate" driers. A number of processes have been devised and patents taken out for the utilisation of the oil in the manufacture of linoleum, rubber substitutes, waterproof paper, etc., but it is not possible to state to what extent the oil is used for such purposes at the present time.

The Japanese "Wood-oil" Tree

Heretofore, as the synonomy cited in an appendix to this article (p. 460) shows, the Japanese Wood-oil tree (*A. cordata* R. Br.) has been confused with the two Chinese species. In order to clear up this confusion some account of the Japanese tree appears necessary. I have not seen this tree in a living state, and my knowledge of it is derived from herbarium specimens and various literature. The first mention of this tree in European literature occurs in Kaempfer's *Amœnitat. Exotic.* fasc. v. 789 (1712), under the Japanese name of "Abrasin." Thunberg (*Fl. Jap.* 267, t. 27 (1784)), named the tree *Dryandra cordata*, and gives a very good figure of the flowers and leaves. Under

PLATE XIII



3 1 2

Fruits of (1) *Aleurites montana* Wils., (2) *A. Fordii* Hemsl., (3) *A. cordata* R. Br. Natural size.

this name Banks (*Icon. Kaempfer*, t. 23 (1791)), published Kaempfer's original drawing of the young fruit and leafy shoots. Both Kaempfer and Thunberg mention that the seeds yield a useful oil. Thunberg states that it occurs wild in central Japan. Franchet and Savatier (*Enum. Pl. Jap.* i. 425 (1875)), apply the name *Elæococca cordata* to this tree, and give numerous localities from central to southern Japan. Lastly in this connection, Shirasawa (*Icon. Ess. For. Jap.* i. t. 56 (1900)), figures both flowers and fruit, and states that the tree is cultivated in the warmer parts of Japan. From the above, not to mention other authorities, it may be fairly assumed that this tree is both wild and cultivated in Japan, and very probably it also occurs in the Liu-kiu Islands.

In general appearance, size, habit, and foliage the Japanese species is similar to *A. montana* Wils., of sub-tropical, south-eastern China, and, like that species, produces its flowers at the end of the current season's growth, after the leaves are fully expanded. The flowers are borne in branched, erect, cymose panicles, and there is a decided tendency towards separate male and female inflorescences, but these are produced on shoots growing close together on the same branch. The flowers are rather smaller than in *A. montana*, and the leaves on the flowering branches are often three-lobed. The fruit of *A. cordata* is somewhat turbinate and trigonous (Plate XIII., Fig. 3), about 2·5 cm. long, wider than long, flattened and often depressed at the summit, slightly tapering to the pedicel, with three slight longitudinal and several irregularly transverse ridges (verrucose). The "fleshy" part of the fruit is thin, soft, and fibrous, and encloses three to five seeds, which are smooth, compressed, subglobose, 1·5 cm. long and broad. The fruit of this Japanese species is therefore much smaller, more fragile, and is very distinct from that of the two Chinese species (Plate XIII.), and indeed equally so from any other known member of the family.

According to Rein (*The Indust. of Jap.* p. 156 (1889)), the oil expressed from the seeds of *A. cordata* is used in Japan chiefly as an illuminant. This authority states that the tree is of medium size, with wide-spreading crown, and that

it is usually planted in soil that is unfitted for farming. It has four Japanese names, viz. "Dokuye," "Yama-giri," "Abura-giri," "Abura-no-ki," the last name signifying "Oil-tree." The Japanese botanists, Hayata (in *Jour. Coll. Sci. Tokyo*, xx. art. 3, 55 (1904)), and Matsumura (*Ind. Pl. Jap.* ii. 300 (1912)), give only "Abura-giri" as the Japanese name for this tree, and Hayata cites several localities for the tree in the island of Hondo.

Since in the past botanists have confused the Wood-oil tree of Japan with those of China, the chemist may be excused for having done the same with the oil itself. This confusion (in part at least) explains the discrepancies in the results of different observers' analyses of the wood-oils of the Far East. In order to ensure accuracy in the matter of identification, I prefer to quote here only the recent figures obtained from samples secured direct from Japan by Chapman (in *Analyst*, xxxvii. 551 (1912)). This investigator erroneously identifies the source of Japanese wood-oil as *Paulownia imperialis*, which is unfortunate, and could have been easily avoided by submitting a sample of the "nuts" to some botanical institution for determination before publishing the paper. After the article appeared, Prof. W. R. Dunstan obtained some of the "nuts" from Mr. Chapman and forwarded them to me for identification, and in consequence I am able to state positively that they are the seeds of *A. cordata* R. Br.

Chapman (*loc. cit.*) states that, "through the courtesy of the British Consul-General in Kobe, he obtained three samples of Japanese wood-oil which on examination gave the following results:

Sample.	Iodine value.	Specific gravity $\frac{15^{\circ} C.}{15^{\circ} C.}$	Saponification value.	Refractive index at 20° C.	Time of efflux at 15·5° C. seconds.	Polymerisation. Two hours at 250° C.
No. 1 .	158·0	0·9377	195·2	1·5083	1,230	Soft.
No. 2 .	149·0	0·9400	193·4	1·5052	1,620	Soft.
No. 3 .	151·8	0·9349	196·3	1·5034	—	Very soft.

'No. 1' was produced in Wakasa, whilst 'No. 2' came from Idzumo. As to the district from which 'No. 3' was derived, I am not quite sure."

A sample of nuts was also obtained, and from this "a quantity of oil was prepared by extraction with light petroleum and gave on analysis the following results:

Specific gravity $\frac{15^\circ C.}{15^\circ C.}$	0·9351
Iodine value	153·5
Saponification value	193·5
Refractive index at 20° C.	1·5050
Bromine thermal value (rise in degrees Centigrade)	24·5

When heated for two hours at a temperature of 250° C. this sample had not solidified, but was still a viscous oil. On reference to the above numbers it will be seen that with the possible exception of 'No. 2' the specific gravities are very appreciably below those of the Chinese oil, which confirms the statements of Lewkowitsch and other observers. The same applies to the iodine values and refractive indices. Even greater than these differences, however, are the differences in polymerising properties, the Japanese oil remaining quite liquid under conditions such as suffice to convert the Chinese oil into a very hard jelly, which crumbles when rubbed between the fingers and becomes a dry powder."

Conclusions

In any attempt to establish new industries, and particularly those of an agricultural character, the question of labour and its cost is of primary importance. This problem can only be dealt with by those possessing intimate knowledge of local conditions. In China, labour is notoriously cheap, although, as elsewhere in the world, there is now a decided upward tendency. It cannot be said that the maximum export of wood-oils from China has yet been reached, but the economic conditions briefly alluded to early in this article show that in the nature of things there must be a limit to the output of these products, which is independent of the ordinary laws applicable to and governing supply and demand in occidental countries. Since the demand for these oils will undoubtedly increase, it would appear essential that the source of supply be extended.

The utilisation of waste products in arts and commerce

has made enormous strides during the past quarter of a century. The science of agriculture has much concern with instructing the world how best to utilise the waste lands of the earth. The object of this article is to give the facts concerning Chinese wood-oils and the trees yielding them. It is for the various departments of agriculture in the warm-temperate and sub-tropical parts of the world to weigh with professional acumen the *pros* and *cons* as to the advisability or otherwise of attempting in the countries, whose people it is their business to educate in matters agricultural, the experimental culture of the trees yielding Chinese wood-oils.

The photographs illustrating this article were taken in China by the author for the Arnold Arboretum, and are reproduced by courtesy of Prof. C. S. Sargent, Director of that Institution.

APPENDIX

REVISION OF SYNONYMY WITH PRINCIPAL REFERENCES

Aleurites montana Wilson, n. comb.

Dryandra oleifera Lamarck, *Encycl. Méth. Bot.* ii. 329 (quoad fruct.) (1786).

Vernicia montana Loureiro, *Fl. Cochinch.* 587 (1790).

D. Vernicia Correa in *Ann. Mus. Hist. Nat. Paris*, viii. 69, t. 32, fig. 1 (1806).

Elæococcus Vernicia Adrien de Jussieu apud Sprengel, *Syst. Veg.* iii. 884 (1826); Steudel, *Nomencl. Bot.* ed. 2, 1, 545 (1840).

Aleurites Vernicia Hasskarl in *Flora*, xxv. pt. ii. *Beibl.* 40 (1842).

A. cordata Mueller Arg. in De Candolle, *Prodr.* xv. pt. ii. 724 (pro parte) (1866); Bretschneider, *Early Res. Fl. China*, 172 (1881); Hemsley in *Jour. Linn. Soc.* xxvi. 433 (pro parte) (1894), in *Kew Bull. Misc. Inform.* 1906, 120 (exclud. speciminibus Japon.); Dunn, *Rep. Bot. For. Dept. Hongk.* 1905.

South-eastern China: province of Fokien southward to Tongking.

It is highly probable that *A. verniciflua* Baillon, (*Hist. Pl.* v. 116, fig. 170, 171 (1874)), belongs here, but the seed only is figured, and this might well represent that of *A. Fordii* Hemsley.

A. Fordii Hemsley in *Hooker's Icon.* xxix. tt. 2801, 2802 (1906), in *Kew Bull. Misc. Inform.* 1906, 120; *Bull. Imp. Inst.* v. 134 (1907); Fairchild in *U.S. Dept. Agric. Circ.* No. 108, with figs. (1913).

Elæococca verrucosa Adrien de Jussieu, *Euphorb. Gen. Tent.* 38, t. 11, fig. 35 (quoad fruct. et semen) (1824).

Dryandra oleifera Wallich, *Cat.* No. 7958 (nomen nudum) (1828) non Lamarck.

Aleurites cordata Hooker f., *Fl. Brit. Ind.* v. 384 (1887) (non R. Brown); Hemsley in *Jour. Linn. Soc.* xxvi. 433 (exclud. synon. et speciminibus e Hainan, e Hongkong partim) (1894); Diels in *Bot. Jahrb.* xxix. 430 (1900); A. Henry in *Chemist and Druggist*, May 31, 1902; Hosie, *Rep. Prov. Ssuch'uan*, 34 (China No. 5), 1904; Pampanini in *Nuov. Giorn. Bot. Ital.* n. ser. xvii. 410 (1910)

China: central provinces from coast to near the borders of Eastern Thibet; also in the south-western province of Yunnan.

A. cordata R. Brown apud Steudel, *Nomencl. Bot.* 286 (1821); Mueller Arg. in De Candolle, *Prodr.* xv. pt. ii. 724 (quoad specimina Japon.) (1866); Shirasawa, *Icon. Ess. For. Jap.* i. t. 56 (1900); Hayata in *Jour. Coll. Sci. Tokyo*, xx. art. 3, 55 (*Rev. Euphorb. Jap.*) (quoad plantam Japon.) (1904); Hemsley in *Kew Bull. Misc. Inform.* 1906, 120 (quoad specimina Japon.); Matsumura, *Ind. Pl. Jap.* ii. 300 (exclud. synon. *Vernicia montana*) (1912).

Dryandra cordata Thunberg *Fl. Jap.* 267, t. 27 (1784); Banks, *Icon. Kaempfer*, t. 23 (1791).

D. oleifera Lamarck, *Encycl. Méth. Bot.* ii. 329 (exclud. fruct.) (1786).

Elæococca verrucosa Adrien de Jussieu, *Euphorb. Gen. Tent.* 38, t. 11, fig. 35 (excl. fruct. et semin) (1824); Siebold and Zuccarini in *Abh. Akad. Münch.* iv. pt. ii. 145 (*Fl. Jap. Fam. Nat.* i. 37) (1843).

E. cordata Blume, *Bijdr.* xii. 618 (1825); Miquel in *Ann. Mus. Lugd.-Bat.* iii. 127 (*Prol. Fl. Jap.* 291) (1867); Franchet and Savatier, *Enum. Pl. Jap.* i. 425 (1875).

Elæococcus verrucosus Adrien de Jussieu apud Sprengel, *Syst. Veg.* iii. 884 (1826); Steudel, *Nomencl. Bot.* ed. 2, i. 545 (1840).

Aleurites japonica Blume ex Miquel in *Ann. Mus. Lugd.-Bat.* iv. 120 (quasi synon.) (1868).

Paulownia imperialis Chapman in *Analyst*, xxxvii. 551 (1912) non Siebold and Zuccarini.

Southern Japan: Hondo, various localities *ex* Hayata, Franchet and Savatier; also cultivated.

THE ORGANISATION OF EXPERIMENTAL WORK IN AGRICULTURE IN THE GERMAN COLONIES

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The economic prosperity of the German colonies is based primarily on agricultural production. Although here and there valuable mineral discoveries, such as the diamonds and copper of South West Africa and the phosphate deposits of the Pacific Colonies, have become of great economic importance to these particular colonies, such occurrences are exceptional. Similar gratifying incidents may perhaps be repeated in these or other places, but agriculture will always remain the backbone of the prosperity of the German colonies.

When the present condition and future prospects of agriculture in these colonies is considered somewhat more closely, very different pictures present themselves, since the three factors—climate, soil, and man—which lie at the base of all agricultural production, differ greatly in the various countries. The three German colonies in tropical Africa—German East Africa, Kamerun, and Togoland—reveal, in respect of climate, soil, and inhabitants, considerable differences. German East Africa and Togoland are dominated by the savannah climate, which prevails over large tracts of tropical Africa, a climate which prescribes certain natural rules for plant cultivation and which especially sets certain definite limits to plantation culture under European management. Aided by the climate, man in earlier times considerably diminished the enormous covering of forest, which extended over the country, and in some cases quite obliterated it, and this has naturally proceeded furthest in the areas that were first settled. This deforestation must have seriously affected the chemical and physical properties of the soil, and only on the mountains or in specially favoured parts of the lowlands have the forests remained undisturbed, and here the soil is of greater fertility and higher water content.

Kamerun, owing to its position on the Gulf of Guinea, is, on the other hand, exceptionally favoured by nature in respect of climate. Not merely the broad belt of primeval forest, which is among the most rainy parts of the globe, but also the grass-land lying behind, have a very favourable rainfall. The Kamerun forest zone with its superior soil, partly of volcanic origin and partly lateritic loam in nature, offers a wide scope for the cultivation of plants of economic importance in European plantations. Cocoa, tobacco, and Para rubber, for example, can be established in such parts, whilst in East Africa coffee cultivation must be restricted to the more rainy, wooded regions in some of the mountainous districts. Sisal hemp, Ceara rubber, and more recently, cotton have found a suitable home in the steppes of East Africa. In Togoland, where, in the forest region near the boundary of the Gold Coast Colony, cocoa cultivation is extending more and more among the natives, it should be possible to cultivate on the plains less exigeant plants, as in the savannah districts of East Africa. The extension of plantations in this colony is hindered by the occasional poverty of the soil and especially by the character of the natives, whilst in the more thickly populated parts the more valuable stretches of level soil are required for raising native foodstuffs.

In these German colonies, as in all other parts where land is being opened up for agriculture, the conditions of settlement of the natives, the density of the population, the general standard of civilisation, whether the people are in settled communities or nomadic, the capacity of the natives for any particular kind of activity, all play an important rôle. And in proportion as the people incline towards agriculture, so attention must be paid to the inclinations and needs of the separate races, and lastly to the extent, organisation, and methods of native agriculture. All these matters, in association with climate and soil, form the basis for future native economic development under the guidance of the colonising nation.

The German colonial government has laid it down as a principle that native agriculture in the tropical colonies

should be allowed to develop freely side by side with plantations under European control, wherever this does not interfere with higher interests. Local conditions will decide how far in each particular region this or that method of organising agriculture is to be preferred. But where-ever climate, soil, and condition of settlement do not admit of plantation culture, and a native population capable of production is present, the government will, as a matter of course, encourage native agriculture as much as possible, and by this means create an improved economic position. This holds good for Togoland, for great parts of German East Africa, and for the Kamerun grass lands.

In the Pacific colonies of New Guinea and Samoa, where the conditions are specially favourable to extensive plantation culture, it is also important that native agriculture should not be overlooked. The link between cultivation on a large scale by white men and on a small scale by natives is formed by the coconut palm, which dominates the whole agricultural life in these colonies.

In German South West Africa the conditions are otherwise. This country is, by reason of its nature and its sparse population, a colony of settlement *par excellence.* Here it is possible for the white man himself to till the land and to engage in stock-farming. Here he can rear up a family, which can become established and remain there for generations.

Stock-farming still provides on every hand in the German colonies great problems, on the solution of which the future position of agriculture in the tropical African possessions depends in a high degree. These problems will be far more difficult to solve than those relating to the cultivation of the land. Stock-raising and stock-keeping are still frequently impossible in large regions of East Africa, Kamerun, and Togoland, owing to the endemic existence of the "Surra" disease and its carrier, the "tsetse" fly. One of the most important tasks of medicine and veterinary science will be to find an effective remedy for "Surra" and the sting of the dangerous "tsetse" fly, a problem whose solution would be of enormous consequence to agriculture in the whole of tropical Africa. But even in

those parts of these colonies where "Surra" and the "tsetse" fly do not occur, and where stock-raising by the natives has been able to develop undisturbed, there is need almost everywhere of a fundamental reformation of the methods of breeding, and the introduction of better breeds of cattle.

As the following summary shows, experimental work was commenced as far back as the occupation of the colonies. At that time Germany entered upon the path which at the commencement was trodden also in the British, Dutch, and French colonies, and which was naturally followed in the newly opened tropical lands. That is to say, Germany began with the establishment of experimental gardens for raising imported economic plants, such as coffee, cocoa, rubber, etc., in the interest of plantation culture, and for the advancement of gardening and fruit production. A change, or rather a completion of this system came about when the European settlers took up agriculture on their own account. It was then found that the experimental work of the botanical gardens was no longer adequate to the new requirements. For this purpose experimental work must be carried on on a purely agricultural basis. In addition there came still another demand, viz. the improvement of native agriculture. For this work specially organised institutes and agricultural staffs were needed. The measures taken in Togoland in 1900 for the introduction and extension of cotton cultivation became the standard for agricultural experimental work in the three tropical African colonies.

There was then nowhere in tropical Africa any model or pattern for the rational practice of cotton cultivation. The natural conditions of Egypt and the United States were entirely different, and in new countries new ways and means must be sought.

In Kamerun the cultivation of the oil-palm and the systematic exploitation of the enormous stocks of wild oil-palm and rubber were also taken up, whilst the introduction of cocoa cultivation and the production of other materials for export by the natives started new tasks. In almost all the colonies cattle-raising ultimately demanded more specialised experimental work.

From these preliminary remarks it will be apparent that agricultural experimental work in the German colonies has been and still is confronted with many and serious tasks.

I now proceed to give some examples of what has been done in the way of agricultural experiments in the different colonies.

(1) German East Africa

The Biological-Agricultural Institute at Amani, in the Usambara Mountains, was founded in 1902. Since then it has developed into a well-equipped, scientific institute, and in 1909, when the Imperial Government at Daressalam created a Department of Agriculture, it became the centre for the organisation of the agricultural staff, which has to discharge all official duties connected with the development of agriculture in the protectorate.

Experimental work is carried on by the stations mentioned below, whilst the purely scientific researches are conducted by the Biological-Agricultural Institute at Amani.

Three special scientific officers have been appointed by the Government to deal with work relating to manures (*see below*), for soil investigations, for practical stock-farming researches in the districts suitable for this industry, and finally for the study of cotton pests and diseases. In administrative districts, where agricultural products are raised in large quantities for export, and where the natural conditions and existing circumstances of settlement and trade make it possible, agricultural assistants are maintained. These act as district agriculturists, and at the same time as travelling instructors to the natives. Their number will soon be increased. At the present time eight agriculturists have been appointed to the following districts: Bagamoyo, Daressalam, Kilwa, Lindi, Kissaki, Morogoro, Rufidji, and Tabora. In the three last-named districts these officers also act as assistants in the local cotton stations (*see below*).

The protectorate is provided with five effective agricultural experiment stations and one experimental fruit

farm. In 1913 the white agricultural staff of the colony consisted of 15 first grade, 10 second grade, and 5 third grade officers.

(1) *Biological-Agricultural Institute, Amani. Situated in the Usambara mountains in the Tanga district.*—This is an institute for research in natural science, and possesses botanical, chemical, and zoological laboratories. Experimental gardens and plantations exist at Amani and at Sigital. The scheme of work comprises the introduction and cultivation of tropical economic plants, scientific research and experiment in the interest of the planting industry in German East Africa, the study of plant pests and diseases, manurial experiments, soil analyses, technical research on the more valuable indigenous products, and the holding of courses of instruction for planters.

The scientific staff consists of a director, two chemists, two botanists, and a zoologist. In addition a head gardener and several other gardeners are employed.

(2) *Kibongoto Agricultural Experiment Station at Kilimandjaro, Moschi district.*—This experiment station, which was founded in 1911, serves primarily the special needs of European planters in the Kilimandjaro and Meru mountains. It carries on all branches of agriculture (tillage operations, plantation culture, management of pastures, and breeding of cattle), variety and cultivation experiments with cotton, Turkish tobacco, coffee, cereals, leguminous crops and other vegetables, the raising of local races of cotton and the most important kinds of grain, experiments with fodder plants for the improvement of pastures and the hay crop, and with green manures. Of the special work particular mention may be made of the experiments on the cultivation, curing, and fermentation of Turkish tobacco, problems not easily solved, though exceedingly important.

The work in cattle-breeding concerns itself in the first place with the indigenous races of cattle and with experiments on Franconian cattle imported from Germany, whilst arrangements are also made for experiments with small stock, in particular with the breeding of pigs and wool-bearing sheep.

The European staff consists of a manager, who is an

agricultural expert, a trained scientific assistant, and a Turkish tobacco planter.

In the last three years three special experiment stations for cotton cultivation ("cotton stations") have been established for the advancement of cotton cultivation in the protectorate. Their programme of work embraces: (1) Comparative cultivation experiments with different species and varieties of cotton, with a view to finding out which of the better known kinds are most suitable for local conditions. (2) Breeding experiments for the production of more valuable varieties and local races from specially suitable kinds of cotton, by means of continued individual selection, and the increase of the best sorts by mass selection for the production of seed. (3) Rotation experiments with various other crops. (4) Experiments on the proper working of the soil and on green manuring. (5) Observations and experiments concerning cotton diseases and pests. In addition the chief officials of these stations have to assist with advice the European cotton planters in their respective districts, whilst the assistants act as travelling instructors to the natives.

(3) *Mpanganya Cotton Station on the Rufidji river, Mohorro district.*—Founded in 1904 as a cotton school of the Kolonial-Wirtschaftliches Komitee. In 1910 it was taken over by the Imperial Government, and whilst continuing the school work for the natives, it was laid out as a special experiment station for cotton cultivation and selection.

The European staff consists of an agricultural expert as manager, and an agricultural assistant.

(4) and (5) *Myombo Cotton Station, near Kilossa, Morogoro district, and Mabama Cotton Station, near Tabora.*—These stations, which were founded respectively in 1911 and 1912, provide no school instruction, but in all other respects do the same kind of work as the Mpanganya Cotton Station.

The establishment of two additional cotton stations, in the Lindi and Muansa districts, is planned for 1913.

Finally, of the newer establishments, mention may be made of the *Morogoro Station for Fruit Culture*, which was founded in 1910. The work here comprises the cultivation of tropical fruit trees and the distribution

of young plants to Europeans and natives. The only European member of the staff is the manager.

(2) Kamerun

Until 1911 the Experimental Institute for Agriculture in Victoria served as the centre for the whole of the experimental work in the colony. In that year the Imperial Government at Buea created a Department of Agriculture, which has since then dealt with all questions relating to organisation, while the technical and scientific investigations are undertaken by the Experimental Institute. At first the agricultural work was devoted mainly to aiding the planting industry in the Kamerun mountains, but as the colony became opened up fresh problems naturally presented themselves. The large stocks of rubber (*Funtumia elastica* and Landolphia vines) constitute not the least of the natural wealth of the colony. The reckless exploitation of the rubber forests carried on some time ago led to the establishment of a special rubber inspectorate (*see below*). A similar organisation, the oil-palm inspectorate, is about to be instituted. The chief duty of the latter will be to lay the groundwork of a system for the proper exploitation of the large, and hitherto unused, stocks of wild oil-palms, and to instruct the natives in a rational system of oil-palm culture.

Various arrangements exist for the development of native cultivation. Some years ago special small experimental gardens were created in the larger administrative stations of the interior. These deal with the cultivation by natives of products suitable for export. In each case a farmer or gardener has been appointed to take charge of the station. More recently larger, more specialised organisations, a cocoa inspectorate, and an experiment station for native cultivation, have been established. The former is concerned with the introduction of native cocoa cultivation in those districts where European cocoa plantations do not exist, and where they are unlikely to be established. The object of the experiment station for native cultivation in Nomajos, Jaunde district, which is not yet complete, is to encourage the cultivation of such crops as ground nuts, plantain and manioc, with a view to their export.

As cotton has been cultivated by the natives in the Kamerun grass lands from ancient times, and the conditions are favourable for its extension over large areas, as in Bamum and Adamaua, two agricultural experiment stations, devoted primarily to cotton cultivation, have been founded in recent years at Kuti and Pittoa. The programme of work at these stations (*see below*) also embraces other branches of agriculture, including stock-raising.

Besides the five stock-breeding stations mentioned below, the oldest of which has been in existence for 15 years, a new and larger experiment station for cattle-breeding will be established at Bamenda in 1913. In those districts of the grass land where cattle are abundant, a uniform, systematic improvement of the native cattle is needed, as well as the instruction of the natives in rational methods of cattle-breeding and management.

Another urgent need is that horse-breeding, which has been established in Adamaua for a long time, should be brought up to a higher grade, both in quality and in quantity. For this purpose a governmental stud farm is being established at Golombe in Adamaua.

In 1913 the agricultural staff consisted of 14 first grade, 7 second grade, and 28 third grade officers.

(1) *Experimental Institute for Agriculture at Victoria.*—A Botanic Garden was founded in 1891, and botanical and chemical laboratories were added in 1905, thus constituting the present Institute. The work carried on includes the raising of tropical economic plants, the distribution of seed and plant material, experiments on plantation culture, especially as regards cocoa, rubber, and the oil-palm, manuring experiments, and scientific and technical research.

Since 1910 an agricultural school has been attached to the Institute, in which young natives are trained as plantation managers.

The scientific staff consists of a director, chemist, and botanist, whilst a garden inspector and several gardeners are employed in the Botanic Garden.

(2) *Cattle Farm and Dairy at Buea, Buea district, in the Kamerun mountains.*—Founded in 1898. Carries on the pure breeding of Allgau cattle and distributes pure-bred

bulls and cows for breeding purposes to other official centres and to private individuals. It supplies Buea and district with dairy produce and also carries on pig-breeding.

(3) *Buea Sub-Farm.*—The work of this farm, which was founded in 1901, includes cross-breeding experiments with Allgau bulls and indigenous cows, the production of draught cattle for the Government service in Buea and Victoria, the supply of Buea, Soppo, and Victoria with cattle, and the cultivation of maize and potatoes.

(4) and (5) *Cattle-Breeding Stations at Dschang and Djuttitsa, Dschang district.*—These stations, which were founded in 1909, carry on cross-breeding experiments with Allgau bulls and Kamerun humped cows at Dschang, and pure-breeding of the local humped cattle at Djuttitsa. Fodder for the herds of cattle is cultivated at both places. In Dschang the agricultural officers also supervise the local breeding of cattle and their improvement in the district, among other ways, by supplying Adamaua bulls to the natives for breeding purposes.

(6) *Dschang School of Agriculture.*—This school was founded in 1909. Here young natives are instructed in the use of the plough and in other rational methods of agriculture.

Stations 4, 5, and 6 are under one manager; an agricultural assistant and a subordinate staff of Europeans are also employed.

(7) *Jaunde Cattle-breeding Station, Jaunde district.*—This was founded in 1911. The cross-breeding of Allgau bulls and Kamerun humped cows is carried on, with the object of obtaining draught cattle for the district and supplying meat and dairy produce to the Europeans.

(8) *Kuti Agricultural Experiment Station, near Fumban, Bamum district.*—This station, which was founded in 1912, serves primarily for the advancement of cotton cultivation in the district, and the programme of work in this direction is the same as that at the cotton stations in German East Africa (see p. 468). The work also includes comparative cultivation experiments with indigenous cereals, pulses, and root-crops, as well as fodder plants; experiments on

the introduction of cultivation by the plough; manuring and rotation experiments; cattle-keeping and cattle-breeding; and the training of native travelling instructors.

The European staff consists of an agriculturist as manager, and an agricultural assistant.

(9) *Pittoa Agricultural Experiment Station, near Garua, Adamaua.*—This station was also founded in 1912 and has the same objects, programme of work, and personnel as that at Kuti.

(10) *Rubber Inspectorate*, with stations for rubber cultivation at Sangmelima, Ebolowa district; Akonolinga, Jaunde district; Dume, Dume district; Djahposten, Lomie district. Founded 1907–09.

The work carried on comprises the distribution of Funtumia and Hevea plants to the natives; the superintendence of new plantations; the regeneration of the stocks of wild rubber which have become exhausted by careless exploitation, and the instruction of the natives in the tapping of rubber trees, and in the preparation and preservation of rubber.

Each station is in charge of an assistant officer who is subordinate to the Inspector of the rubber district.

In order to deal adequately with the agricultural questions which arise locally in the various districts, most administrative stations possess, apart from the established experimental gardens mentioned above, agricultural officers whose duty it is to superintend local experimental fields and gardens. Such officers are employed at the following stations, among others: Duala, Edea, Bare, Yoko, and Bamenda. The chief aim of the experimental gardens at these stations is to develop the cultivation of export products, whilst experiments with foreign economic plants yielding produce suitable for export are also conducted.

(3) German South West Africa

The peculiar conditions of this country have made it necessary to specialise to a high degree, both in the experimental work and the agricultural staff. Stock-raising occupies first place in the agriculture of the country, and as a matter of course the government devotes special

care to the advancement of the different branches of animal-breeding. The following survey of the existing institutions in German South West Africa hardly needs any further explanation.

The cultivation of the soil was at one time in the background in the development of agriculture in the country, but it has recently come more and more to the front. This is borne out by the fact that of three experiment stations created in recent years, one is for general tillage and one specially for tobacco cultivation.

The Imperial Government at Windhuk has appointed four agricultural experts, one for the study of each of the following subjects: (i.) cattle-breeding, (ii.) sheep-breeding, (iii.) agriculture, (iv.) fruit and vine culture.

The expert in sheep-breeding is also the manager of the Karakul sheep-breeding farm at Fürstenwalde (*see below*), whilst the agriculturist manages the Neudamm experimental farm (*see below*).

(1) *Experimental Farm for Tillage in Neudamm, near Windhuk.*—Founded in 1911. The work comprises comparative cultivation experiments with corn and fodder plants, as well as experiments in "dry-farming."

(2) *Experiment Station for Tobacco Cultivation at Okahandja.*—Founded 1912. This station is devoted entirely to the advancement of tobacco cultivation in the country. Comparative cultivation experiments with various kinds of tobacco are carried on, as well as experiments on the preparation of tobacco.

The European staff comprises an agricultural expert and an agricultural assistant.

(3) *Imperial Stud Farm at Nauchas.*—Founded 1898. This stud farm is the centre for the breeding of horses in the colony. Breeding experiments with imported thoroughbreds are carried on, for the purpose of obtaining farm stallions and the production of a uniform type of horse, whilst the organisation and supervision of the stallion service in the country is also dealt with. The European staff comprises a manager, a stud attendant, and other minor officials.

(4) *Farm for the breeding of Karakul Sheep, Fürstenwalde,*

near Windhuk.—Founded in 1909 with animals imported from Bokhara. Pure-breeding and cross-breeding of the sheep are carried on here.

(5) *Otjituezu Experimental Farm for the breeding of Ostriches, on the White Nossob in the Windhuk district.*—Founded in 1911. The work comprises the pure breeding of imported brood birds and experiments with indigenous wild ostriches. The European staff consists of a manager and an assistant.

The older experimental gardens of the country, in part established in 1897–99, serve particularly for fruit and vegetable culture. Experimental gardens of this kind are situated at Windhuk, Grootfontein, Bethanien, Gobabis, and Klein-Windhuk.

(4) TOGOLAND

It has already been mentioned in the introduction that there is no important European planting industry in this colony. On the other hand, the, for the most part, thickly settled land possesses an active, intelligent population with an inclination towards agricultural work. The agricultural methods of the negro, especially in the south, are however on a low level, so that a continuous and well-regulated system of instruction for the natives is needed, in order to make production more effective both for local consumption and for export. To deal with this work the agricultural staff includes travelling instructors (district agriculturists) in all districts of South Togoland, whilst a school for young natives is maintained at the Agricultural Institute, Nuatjä. Cotton cultivation is promoted by means of three cotton stations.

In 1913 the European agricultural staff consisted of 3 first grade, 5 second grade, and 7 third grade officers.

Since 1911 the Governor of the Colony has had available an Agricultural Adviser, for the consideration of all matters relating to agriculture, whilst a second agricultural expert is employed for work relating to plant-breeding and manures.

Five agricultural assistants (district agriculturists) are stationed in the districts of Lome-land, Anecho, Misahöhe,

Atakpame, and Sokode. Those in the three last-named districts supervise cultivation experiments at the cotton stations (*see below*), the supreme direction of which is in the hands of the Agricultural Adviser. The assistants, as already mentioned, act also as travelling instructors to the natives, dealing chiefly with the cultivation of cotton, cocoa, and the oil-palm.

(1) *Nuatjä Institute for Agriculture, Atakpame district.*—Founded in 1912 by the Atakpame station; in 1903 it was handed over to the Kolonial-Wirtschaftliches Komitee as a cotton school for the natives. In 1907 the Imperial Government took it over and it was enlarged as a general agricultural school for natives. In 1912, whilst retaining the school work, it was raised to the status of an Institute for Native Agriculture. Young natives from different parts of the country are given practical and theoretical instruction in rational methods of cultivation and in cattle-keeping. The work includes cultivation experiments with cereal, leguminous, and root crops, manurial experiments, and cattle-, pig-, and goat-breeding.

The European staff consists of a manager, an agricultural assistant, and subordinate officers.

(2) *Nuatjä Cotton Station.*—Founded in 1911 in connection with the farm school at that time existing at Nuatjä. The programme of work comprises comparative experiments with various species and varieties of cotton, as well as the cultivation of selected varieties for seed (cf. the programmes of the cotton stations in German East Africa). The station possesses its own ginnery.

The work of the cotton station is conducted by the staff of the Institute for Native Agriculture.

(3) *Tschatschamanade Cotton Station on the Kamaa river, Sokode district.*—This station, also founded in 1911, carries on similar work to that done at the Nuatjä Cotton Station. The European staff consists of an agricultural assistant acting under the Agricultural Adviser (see p. 474).

(4) *Tove Cotton Station, near Palime, Misahöhe district.*—Founded in 1912. In addition there is a station for the production of cotton-seed at Kpandu. The programme of work and the scale of staff are the same as at Nuatjä.

(5) German New Guinea

The economic development of this colony has hitherto been carried on more one-sidedly than in the German tropical African possessions. Agricultural production is essentially confined to the large planting undertakings in the coastal districts and on some of the islands. As a result, until quite recently experimental work has been only moderately developed and was centred at the Botanic Gardens at Rabaul. These have existed since 1906, and serve as a centre for raising tropical economic plants. In recent years the need for a special organisation, which would be of service to the planting industry and promote the development of native agriculture, has made itself felt. Facilities for scientific research, similar to those afforded by the laboratories at Amani and Victoria (*see above*), are also needed, as well as special experimental plantations for the scientific and practical study of the varieties and races of the coconut palm, particularly as regards their yielding capacity. In order to open up the interior of Kaiser Wilhelmsland, which is richly endowed by nature, an agricultural experiment station ought to be established on the Sepik river. Finally, a special animal-breeding station is necessary, as the country, in spite of its favourable conditions for cattle-breeding, has not been made known in this capacity hitherto, owing to its isolated and unsettled state. The Government has recently perfected a scheme for experimental work and for the organisation of an agricultural department, which has been approved by Parliament, and which will be realised in 1913 and 1914. This scheme embraces the following projects :

(i) An experiment station for the study of the varieties and races of the coconut palm and its diseases and pests, and for experiments in the best methods of preparing copra.

(ii) An agricultural experiment station in Kaiser Wilhelmsland for experiments with rubber, cocoa, rice, sugar-cane, tobacco, and Manila hemp.

(iii) Extension of the Botanic Gardens by the establishment of branch stations.

(iv) An agricultural laboratory at Rabaul for chemical research on local products, soils, etc., and for researches on plant diseases, insect pests, etc.

(v) An animal-breeding station for experiments with various kinds of cattle, pigs, goats, and poultry, for horse-breeding, the cultivation of fodder plants, experiments on the establishment of artificial pastures, and the advancement of cattle-breeding among the natives.

(vi) The appointment of four district agriculturists for the improvement of native agriculture.

On the completion of this scheme in 1914 the agricultural staff of the colony will consist of 5 first grade and 7 second grade officers; the subordinate-staff will be composed of Malays and Chinese.

(6) Samoa

In this colony an Agricultural Expert has been employed since the beginning of 1912, and an experimental plantation is being formed. Diseases and pests of the coconut-palm and of cocoa make their appearance on the island in some years, and as these need special attention, a specially trained scientific officer (phytopathologist) is stationed there.

General Remarks

Extensive and systematic manurial experiments, to determine the nutritive requirements of the most important cultivated plants, have been carried on since 1911 on both the experimental stations and private estates in the tropical colonies of Africa and the South Seas. This experimental work is carried on under the control and at the expense of the Imperial Government, and has been sanctioned for a number of years. The work requires a special staff of agricultural experts and assistants, who are not included in the permanent staff, and in the present survey this personnel is not considered.

As the foregoing review shows, experimental work in almost every branch of colonial agriculture is extending more and more in the German colonies. It is of particular service to the settler, farmer, and planter in the

performance of their most difficult work; it endeavours to show how they can procure as high a return as possible for their farming operations, and it attempts to raise the agricultural output of the natives to a higher level, thereby increasing the whole agricultural prosperity of the colonies. Our experimental work serves ultimately the self-evident demand for a sound national trade policy, especially by encouraging in our colonies the production of those raw materials which Germany must still draw from foreign lands for the sustenance of its people and industries.

An inexperienced colonising people undoubtedly meets great difficulties at the beginning, when its own knowledge of tropical lands is small. Germany has adopted two methods to overcome these difficulties: the first is to learn from the older, more experienced colonial nations, and to bear in mind the experience that has been gained during the lapse of years in foreign dominions. For this purpose experts of the German colonial service have carried out studies in various parts of the world, and, as we gratefully recognise, have received much courteous assistance from foreign governments and private persons, so that they have in each case returned richly informed.

The second method is to transfer to colonial agriculture as far as possible the long-approved system of German agriculture, which rests on a strong scientific foundation, built on the results of exact investigation and methods. In this, however, one has to guard against indiscriminate transfer to the Equatorial regions of practice peculiar to European conditions. The rational methods of German agriculture, perfected by the long and assiduous work of generations, have to be very largely transformed into new methods and systems for employment in the tropics. By this means the German colonial government has kept pace with the present-day organisation of agricultural experimental work in the colonies.

Although only at the commencement of our work, we hope that we are at least proceeding on the right lines.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE OCCURRENCE, DISTRIBUTION, AND USES OF MERCURY

MERCURY or quicksilver ores have been found in all formations from the Archean to the Quaternary in rocks of such widely varying character as sandstones, shales, limestones, quartzites, crystalline schists and basic eruptive rocks. Large deposits are rarely found in eruptive rocks, but they frequently occur near such formations and also in the locality of hot springs.

Mercury deposits, when first opened up, often yield ore carrying as much as 25 per cent. of the metal, but usually the grade soon falls off and the large deposits now being worked rarely yield ore carrying over 3 per cent. of the metal. The most important ore-mineral of mercury is the sulphide, cinnabar, but native mercury and meta-cinnabarite also occur. Tiemannite (HgSe), calomel (Hg_2Cl_2) and native amalgam with silver are rare.

Cinnabar (HgS) is a bright red sulphide of mercury. It usually occurs in a massive or granular condition, but crystals belonging to the trigonal system are sometimes found. It has a bright scarlet streak and a sub-conchoidal fracture. The hardness varies from 2 to 2·5, and the specific gravity is about 8·1. The mineral is readily recognised by the fact that when heated in an open tube it yields a sublimate of mercury and fumes of sulphur dioxide.

DISTRIBUTION OF MERCURY ORES

Europe

Austria-Hungary.—A large proportion of the world's output of mercury is obtained from the State mines at Idria in Carniola, which have been worked since the tenth century, and where deposits of cinnabar occur in rocks belonging to the Alpine Trias series. There are few true veins, the ore occurring chiefly as impregnations in the country rock, associated with quartz, calcite and dolomite.

The cinnabar is found also in pockets and lenticular masses in slates, especially where the latter are contorted and carry organic matter. Native mercury is of fairly frequent occurrence, associated with pyrite.

The ore is worked at six levels, and it is estimated that the reserves will be sufficient to last seventy years at the present rate of working.

Germany.—Only a small amount of mercury ore is now produced in Germany, but at one time important deposits were worked at Obermoschel and Landsberg. The ore is chiefly cinnabar associated with galena, iron and manganese ores, and copper pyrites. Tetrahedrite containing silver and mercury occurs in a group of veins which extend from Rossbach to Roth, and cinnabar occurs in the copper lode at the Neuermath mine in Nanzenbach. Mercury ores also occur in the eastern portion of the Saarbrück coal basin.

Italy.—About one-fifth of the world's production of mercury is obtained from the mines of the Monte Amiata district of Tuscany, which have been worked since 1846. Monte Amiata is an eruptive mass of trachyte, which has been intruded through strata of Eocene age, and the cinnabar is found near the zone of contact of the eruptive rocks with the stratified deposits. These deposits have been classified by Spirek into four types. The first is the Siele Solforate type, in which the mercury-yielding limestone is surrounded in both the hanging and foot walls by an impermeable bituminous clay ("gallestro"). It is with this mode of occurrence that the richest quicksilver deposits are usually associated in this area. The second, or Montebuono type, has a foot wall of "gallestro," but in the hanging wall the limestone is often overlain by a sandstone into which the cinnabar has penetrated. Both the limestone and sandstone are mined for their cinnabar, but yield relatively poor ore. The third type is the Cornacchino, which occurs in the Lias limestone, and has a hanging wall of slate and a foot wall of cherty material (phthanite). The fourth or Abbadia San Salvatore type occurs in the Eocene and Lias limestones which are overlain by trachytes.

The deposits are very extensive, but are much faulted.

The most important mines are those of Siele, Cornacchino, and Montebuono. At the two latter mines ore yielding 0·2 and 0·3 per cent. of mercury is worked at a profit. A full account of the Monte Amiata deposits is given in the *Mining Magazine of New York* (1906, **13**, 277). A general description of the method of smelting employed in this district is given on page 492.

Russia.—At one time Russia made a substantial contribution to the world's output of mercury, but during the past decade the production has steadily declined. In 1905 it amounted to 300 tons of metallic mercury, but fell to 4 tons in 1910, and about 25 tons was obtained in 1911. At the present time it is stated that the only mercury deposits being worked in Russia are those of Nikitovsky in the Ekaterinoslav district of Southern Russia. At these mines the cinnabar occurs crystalline in sandstone of Carboniferous age, and also in the quartzites which underlie the sandstone. The associated minerals are antimony sulphide and sulphur. The ore carries 0·4 to 1·1 per cent. of mercury. In the Urals several deposits of mercury ore have been located, the most important being that of Olene Travyansky. A deposit which may prove to be of some importance has been discovered recently on the Ayatsky estate in Ekaterinberg. On the surface numerous pebbles containing up to 10 per cent. of mercury were found, and at a depth of 5 ft. a vein of cinnabar 3 in. wide was found. A cross-cut disclosed another vein 21 in. wide, the cinnabar being irregularly distributed throughout the mass.

Servia.—The most important mercury ore deposits in the Balkan peninsula occur at Avala, situated about 15 miles south of Belgrade. The ore is cinnabar, and occurs associated with calomel and native mercury in barite-quartz veins which traverse a Cretaceous limestone.

Spain.—About one-third of the world's supply of metallic mercury is produced in Spain, most of the ore being obtained from the famous mines of Almaden in Cuidad Real province. There are also several smaller mines in Oviedo. At the Almaden mines the rocks consist of

upturned slates of Devonian and Silurian age, together with intercalated quartzites. The cinnabar is rarely found in the slates, but occurs in three beds in the quartzite, each about 25 ft. thick and separated from one another by a few feet of soft slate. These beds unite at a depth of about 800 ft. from the surface. The ore is stated to carry on the average about 8 per cent. of mercury. The chief mine in Asturias province is El Porvenir, where cinnabar occurs in rocks of Carboniferous age, accompanied by realgar, orpiment, and metallic arsenic. This ore is said to carry about 0·3 per cent. of mercury.

Asia

Asia Minor.—Several years ago ancient workings were located at Koniah, and these have since been profitably worked. The cinnabar occurs in small veins and nodules at the contact of a crystalline limestone and a talcose schist. The ore mined contains from 1·5 to 2·5 per cent. of mercury. Cinnabar is here also found associated with stibnite, the ore carrying about 8 per cent. of mercury. The plant installed includes a Spirek shaft furnace and a Czermak-Spirek roasting furnace having a capacity of 15 tons and 8 tons per day respectively.

Important deposits are also being worked at Kara Bourna, about 18 miles from Smyrna, where cinnabar occurs impregnating a siliceous rock. The ore averages 0·75 per cent. of mercury, and it is stated that ore containing as little as 0·25 per cent. can be worked at a profit. A plant similar to that at Koniah is in operation.

Borneo.—Native mercury and its ores have been found in many parts of Borneo, and occasionally small quantities of the metal have been exported. Native mercury has been found near Marup at Sadong in Sarawak. Deposits of ore occur in the upper basin of the Sarawak River in the Samarahan district, and small quantities of cinnabar have been obtained from the rich drifts which flank the Tejora and Gading hills.

Cinnabar has been found in many places in West Borneo, but the results of prospecting carried out some years ago indicated that the deposits would not repay

working. At Nanga Betung, cinnabar occurs associated with iron pyrites, and also in drifts with antimony sulphide.

In South Borneo, mercury ores occur associated with gold, copper, and tin ores in the drift deposits of Lower Katingan and Kataringin. In the Bawang Mountains cinnabar has been found disseminated in phyllite at Sungei Sekire. A full account of the occurrences of mercury ore in Borneo is given in *Borneo, Its Geology and Mineral Resources*, by T. Posewitz (London: E. Stanford, 1892).

China.—Mercury is much used in China as the source of the pigment vermillion and for gilding. Ores of mercury are reported to occur in many parts of China, but at the present time the only mines known to be of any importance are those of Yuan Shan Chiang, which are situated in the south-east part of Kweichow Province. The cinnabar occurs as impregnations and bunches in nearly horizontal beds of magnesian limestone. The ore mined contains an average of 2·8 per cent. of mercury, and is smelted in two 12-ton furnaces.

India.—Cinnabar has been reported to occur in India, but the reports appear not to have been substantiated. India imports about 160 tons of mercury annually.

Japan.—Deposits of mercury ore occur in several localities in Japan, but no production of the metal was recorded until 1908. In that year mercury to the value of £144 was obtained from the Suigin mine at Suii, in Shikokw, where cinnabar occurs in the form of small veins along a fault-plane in Mesozoic limestone.

Africa

Algeria.—For some years past small quantities of mercury have been exported from Algeria, most of the ore coming from the localities of Taghit and Ras-el-Ma. The cinnabar occurs at Taghit associated with zinc blende, calamine, siderite, and galena, and is stated to carry, on an average, 1·2 to 1·5 per cent. of mercury, and 5 to 15 per cent. of zinc. Works for treating the ore were built in 1903, and now include a Spirek shaft furnace having a capacity of 6 tons per day, and Czermak-Spirek roasting and calcining furnaces of similar capacity. A full account

of these deposits and others in Algeria will be found in *Les Richesses Minérales de l'Afrique*, by L. de Launay (Paris: J. Béranger, 1903).

Union of South Africa.—Although large quantities of mercury are consumed in the gold industry, and ores of mercury have been found in several localities, no appreciable quantity has yet been produced in South Africa.

In the Transvaal cinnabar has been found in quartzites and altered slates in the Kaap Valley. It also occurs in a quartzose sandstone in the Lebombo Mountains to the east of De Kaap, and associated with galena and zinc blende at the Erasmus mine in the Marico district.

It is stated that mercury deposits situated near Hector Spruit on the Delagoa Bay line have been worked to a small extent (*Mineral Industry*, 1907, **16**, 818).

Cinnabar has been reported to occur at Mosita, about 50 miles south of Mafeking, and native mercury associated with gold in the Prince Albert district of Cape Province.

Australian Commonwealth

New South Wales.—Cinnabar has long been known to occur in this State, and smelting of the ore was carried out on a limited scale at Cudgegong as far back as 1869. The production has, however, been small, and a bonus of £500 offered by the New South Wales Government for the first 50,000 lb. of mercury produced from ore raised in the State is still unclaimed.

Cinnabar was located many years ago in a lode at Spring Creek, situated about 3 miles south-east of Bingera. The ore occurs disseminated through a dyke of decomposed serpentine rock, but the yield of mercury, as shown by samples of ore from the shafts sunk, did not justify further development.

In 1895 cinnabar was found at Yulgilbar, about 7 miles from Lionsville, on the Clarence River. The country rock consists of a hornblende granite, into which a dyke of quartz diorite has been intruded. The cinnabar is found near the junction of these rocks, and occurs associated with quartz and calcite. A considerable amount of development work has been done on this deposit, and it

is stated that there is a good supply of ore carrying 0·5 to 1·0 per cent. of mercury. At a depth of 70 ft. carbonate of copper is found with the cinnabar. In 1902 an attempt was made to work these deposits, and a 50-ton shaft furnace was erected.

A considerable amount of prospecting work has been done during recent years on a deposit situated at Pulganbar on Gordonbrook in the Copmanhurst division. During 1911 about 300 tons of low-grade and 50 tons of rich ore were raised and smelted in a small furnace. A larger plant is now being installed for treating the ore.

A full account of the above occurrences, together with eighteen other localities in which mercury ore has been found, is given in the *Mineral Resources of New South Wales*, by E. F. Pittman (Sydney: W. A. Gullick, 1901).

Queensland.—Mercury ore was raised and smelted many years ago in this State, but during recent years little work seems to have been done in this direction. Between 1874 and 1891 about 41 tons of metallic mercury was produced from the Kilkivan mines and utilised in the Gympie district.

It is stated that eight lodes were located in the Kilkivan district, in the valley of Wilde Bay Creek, distributed over a length of about 10 miles. One of the largest lodes is the "Queensland," which is 7 ft. wide in places, and yielded a dressed ore containing 4 per cent. of mercury. About 70 tons of the ore was smelted with rough appliances, and yielded about 2·7 tons of mercury. The lodes are said to occur in granites and schists which are associated with breccias and tuffs. A small parcel of ore was produced in 1908, and it is reported that prospecting has been in progress during the past year. A full account of these deposits will be found in "Alluvial Cinnabar Deposits near Kilkivan" (*Publication* 79, 1892, *Geol. Surv., Dept. Mines, Queensland*).

In the Little River district of North Queensland mercury ores associated with copper ores have been found in veins in andesite. The cinnabar is found best developed in the cavities and joints of the calcite veins where these traverse the kaolinised rock. About 1 ton

of picked ore, containing 5 to 6 per cent. of mercury, was sent to London for treatment, but was reported on unfavourably. The workings have disclosed a mercury lode which averages 18 in. in width at the surface, but decreases to about 6 in. at lower levels. A recent description of these deposits will be found in *Publication* No. 222, 1910, *Geol. Surv., Dept. Mines, Queensland*, and this BULLETIN, 1912, **10**, 138.

Cinnabar has also been found in the following localities in Queensland: Mount Perry, Montalbion, Mungana, Gilberton, Nebo, and Montsildale.

South Australia.—Mercury ore was reported to occur at Myponga, about 8 miles from Willunga, in a formation consisting of clay slates, mica schists, phyllites, and quartzites. A certain amount of prospecting work was done, including the sinking of a 50 ft. shaft and two tunnels 120 and 250 ft. in length, but failed to locate mercury ore in payable quantities.

Victoria.—Mercury ores have been found in this State at Silver Creek on the Jameson River in Wonnangalla, where both the native metal and cinnabar occur in chloritic slates. The deposit was worked for a short time, but proved unprofitable owing to the small yield obtained. The last production recorded was in 1899, when metal to the value of £20 was produced. Fragments of cinnabar have also been found in the vicinity of a quartz reef near Balumwaal in Central Gippsland (*Economic Minerals of Victoria*, by A. E. Kitson. Melbourne: Victoria Department of Mines, 1906).

New Zealand

From time to time attempts have been made to work the deposits of mercury ore which exist in several localities in New Zealand, and small outputs of the metal have been recorded. One of the most recently exploited deposits is the Ascot mine, situated about 1 mile north of Karangahake. The cinnabar, which is stated to occur in horizontal seams in a flinty rock, is smelted in a Novak shaft furnace. In 1911 two tons of mercury, valued at £400, was produced. In the Hokianga division in 1866 mercury was observed

at the Ohaeawai Hot Springs, and in 1895 a company was formed to work the deposits. The ore, which occurs as irregular impregnations in carbonaceous sands and clays, is associated with sulphur, bituminous matter, marcasite, chalcedony, and antimonite. A large amount of development work was done on the deposit, and a reduction plant erected; but the operations stopped in 1897 owing to litigation between the owners. Trouble was experienced in mining the ore owing to the hot spring waters and the sulphurous gases evolved from them. In smelting, the presence of the hydrocarbons caused difficulty owing to the fact that they prevented the aggregation of the mercury. It is stated that the ore contained from 0·5 to 5·0 per cent. of mercury, the average grade being 1·5 per cent. The yield of mercury on smelting amounted to about 70 per cent. of the total amount present in the ore. A full account of the attempt to work these deposits is given in *Trans. New Zealand Inst. Min. Eng.* (1898, **2**, 48).

Cinnabar has also been found in five other localities close to the Ohaeawai Hot Springs; information concerning these is given in a recent report, "The Geology of the Whangaroa Subdivision" (*Bulletin* 8, 1909, *Geol. Surv., New Zealand*).

In 1899 a cinnabar lode was found between Waipori and Waitahuna, in Otago. Some rich ore was obtained at a shallow depth, but an adit failed to locate any considerable amount of ore, and the mine closed down in 1903. A cinnabar lode at Kaweranga Creek in the Thames division was worked to some extent some years ago.

New Caledonia

Deposits of mercury ore carrying from 1·75 to 2·75 per cent. of the metal occur at Bourail, Canala, Konaona and Piwaka, but are not at present worked.

America

Brazil.—In Minas Geraes a deposit of mercury ore has been worked to some extent near Tripuhy station.

Canada.—At the present time no mercury is produced

in Canada; but in the past small quantities have been obtained, the maximum production being in 1895, when 2·4 tons was produced. No production has been recorded since 1897, when the output was 375 lb. The deposits worked were those of Kamloops Lake, British Columbia, where cinnabar occurs in calcite and quartz veins which traverse a grey felspathic and dolomitic rock. The veins can be traced through a section 45 miles long and 1 mile wide running north and south of Kamloops Lake. It is stated that large supplies of ore containing 0·5 to 1·0 per cent. of mercury are available. The failure of the undertaking is stated to be due to the unsuitability of the furnaces employed, and also to the fact that a large amount of development work was done on unpromising locations. A full account of these deposits is given in *Ann. Rep., Geol. Surv. Branch, Dept. Mines, Canada* (1898, **11**, 108 S, 1900, **13**, 87 S). Native mercury has recently been found near Field, in the gravels of Kicking-Horse Valley, British Columbia; but attempts to locate the source of the metal were unsuccessful. Cinnabar, however, was located in a massive limestone on the north side of the valley between Emerald Creek and Amiskwi River. In the Lower Kicking-Horse Canyon cinnabar has been found in a calcite vein near Glenogle Station.

Cinnabar is known to occur on certain islands in Barclay Sound, on the west of Vancouver Island. Average samples of the ore showed 0·5 per cent. of mercury. Important deposits of mercury ore have been reported recently from Groundhog, east of Cochrane, in northern Ontario.

The occurrence of mercury ore at the Nipissing mine in the Cobalt district has already been recorded in this BULLETIN (1911, **9**, 427). The ore is said to carry 4 to 5 lb. of mercury per ton.

Colombia.—Cinnabar occurs in quantity in a mica-slate in the Quindico Mountains between Ibagué and Cartago.

Dutch Guiana.—Mercury ore has been reported recently in the Maroni district as a vein of cinnabar averaging 20 ft. in thickness. The deposit is said to be of considerable extent and to yield rich ore in workable quantity. The

area is receiving the attention of certain Dutch and American mining engineers.

Mexico.—A considerable output of metallic mercury is obtained annually from Mexico. The richest mine so far exploited is stated to be that of Guadalupana in San Luis Potosi. The ore is cinnabar and occurs, associated with calcite and gypsum, in much-folded marlstones. As there is no water near the mine, the ore is conveyed 11 miles to the smelting works. There are no sulphides other than that of mercury in the ore, which is said to carry 10 per cent. of the metal.

At various times attempts have been made to work the Chiquilistlan deposits of Jalisco. Here cinnabar occurs, associated with copper ores and limonite, in the fissures which traverse a hard grey Cretaceous limestone. Other mines that have produced payable ore are situated at Guadalcazar and Huitzuco in the State of Guerrero.

Peru.—There is a small annual output of mercury from Peru, obtained from the Departments of Huanuco and Huancavelica. The mines in the latter locality have been worked since the sixteenth century, the cinnabar belt running N.E. and S.W. for a distance of about 60 kilometres. The chief mines are those of Santa Barbara, situated about 2·7 kilometres from Huancavelica, on the eastern slope of the Western Cordillera of the Andes. The ore mined is said to carry about 2 per cent. of mercury. The production of metallic mercury in Peru for 1910 was valued at £94.

United States.—For several years past there has been an annual production of over 700 tons of mercury in the United States, about 83 per cent. of this being obtained from California, the remainder coming from Texas, Nevada, and Oregon.

The most important Californian deposits are those of New Idria, in San Benito Co., which yielded half the total output of the United States in 1910. The ore bodies are found in metamorphosed rocks of the Lower Cretaceous series, near the contact of these with the unaltered sediments of the Upper Cretaceous series. The ore occurs as irregularly distributed shoots in hard shale and

sandstone. The ore is smelted at the mine, a Hüttner-Scott type of furnace being employed for fine ore and two Newcome furnaces for coarse ore. The furnace operations are assisted by the high content of pyrite in the ore, which also decreases the fuel costs.

The second largest producing deposits in California are those of New Almaden and Guadalupe in Santa Clara Co. The original workings at the Guadalupe mines were situated in the valley close to the Capitancillos Creek, but these had to be abandoned owing to water in the mine. The present workings are in the hillside and are reached by an adit 2,000 ft. in length. The cinnabar, which occurs in a serpentine near its contact with an intrusive rhyolite, is crushed and separated by sifting into grades above and below 1½ in. For the distillation of the mercury oil fuel is used, the consumption being about one barrel per 10 tons of ore smelted. The yield of mercury from the mines in Santa Clara Co. averages 0·4 per cent. on the ore smelted.

Smaller mercury deposits occur and are worked in several other counties in California.

The average recovery of mercury from mines in this State was 0·5 per cent. of the ore treated in 1910.

Mercury ores have been found in many localities in Texas, but at the present time nearly the whole output is obtained from the Terlingua district in Brewster Co. Here cinnabar occurs in Cretaceous limestones and shales into which Tertiary igneous rocks have been intruded. In the past considerable difficulty has occurred owing to a scarcity of fuel and water. In 1910 the yield of mercury for the whole of Texas averaged 1·7 per cent. of the ore smelted.

Some of the richest mercury ore treated in the United States is obtained in Nevada, but the output is small. The average recovery in 1910 was 7·5 per cent. on the ore smelted. Retort furnaces were formerly used, but recently these had to be abandoned owing to injurious effects on the health of the workmen. The most important deposits are situated in Nye and Humboldt Counties.

EXTRACTION OF THE METAL

Mercury is obtained from its ores by a process of distillation which can be easily effected, as the metal boils at a temperature of 357° C. This also renders the separation of the metal from the gangue a comparatively easy matter, but it is necessary to have very efficient means of condensing the vapour, which is poisonous.

As the grade of the mercury ore worked is low, often being about 1 per cent. or less, it is essential to obtain as much of the metal as possible if the work is to prove remunerative. It is stated that lack of effective condensation has led to the abandonment of several promising deposits (see under Canada, p. 488).

Two methods have been generally employed for the smelting of mercury ores. In the one case the ore is heated with lime or iron in the absence of air, and in the other it is heated alone in a current of air. The first method necessitates the use of retorts, and owing to its high cost has been almost entirely abandoned, except for very rich ores. It has also the disadvantage of causing serious injury to the health of the workmen who have to empty the retorts. The second is the one now generally adopted, as it permits of poor ores being treated at a profit. The general practice is to separate the ore into coarse and fine grades and to smelt the coarse ore in a shaft furnace and the fine ore in a reverberatory type of furnace. Numerous varieties of these two classes of furnace are in use, and good descriptions and plans are given in *Mineral Industry* (1901, **10**, 559; 1902, **11**, 548).

In general the shaft furnace may be described as a rectangular, double-walled, firebrick furnace, having an outer covering of cast iron and a base of the same material. The shaft is roughly 22 ft. high and about 7·5 ft. in diameter at its widest part. Ore and fuel are charged into the top intermittently, and the air necessary for the combustion is supplied through holes in the base. Means are provided at the base for the withdrawal of the spent ore. Furnaces of this type include the Novak and Czermak-Spirek.

The second or fine-ore type of furnace, of which there

are many modifications, may be briefly described as one in which the ore passes by gravitation down a series of sloping shelves which are heated by means of an external fire. Typical furnaces of this class are the Czermak-Spirek continuous roasting furnace, the Hüttner-Scott, and the Livermore.

Smelting.—The smelting of the ore, as carried out in the Monte Amiata district of Italy, may be briefly described, as it is typical of modern practice. The ore as it comes from the mine contains 0·2 per cent. or more of mercury, and is graded according to size—(1) below 40 mm., and (2) 40 mm. to 200 mm. The first grade is roasted in an automatic reverberatory furnace, and the second grade in a shaft furnace. Wood fuel, chiefly beech, oak, and chestnut, is employed. For small quantities of ore containing over 20 per cent. of mercury a small automatic reverberatory furnace is used, having a daily capacity of 2 to 6 tons. The products of the roasting are chiefly mercury vapour and sulphurous acid, together with any other volatile products present in the ore. The temperature in the roasting zone in the furnace reaches about 700° C., and the gases leaving the furnace have a temperature below 200° C. In order effectively to collect the mercury, the gases are next passed through condensers consisting of cast iron, clay, or wooden pipes, which are elliptical in cross section, and are cooled by water externally. Those portions of the condensers where the temperature is below 100° C., and where the condensation of acid vapours takes place, are lined with cement to prevent corrosion. The speed of the gases through the condensers is maintained at a constant rate of about 0·5 metres per minute by means of a Roots blower, and by this means effective condensation is assured. More than 6 per cent. of the mercury originally present in the ore is retained in the "stupp" or soot which collects on the walls of the condensers. About 90 per cent. of this mercury, which is in the form of minute globules, is recovered by mechanical agitation of the stupp with 17 to 30 per cent. of its weight of slaked lime. The residue is then returned to a small roasting furnace to recover the remaining metal.

A complete account of the metallurgy of mercury is given in "La Metallurgia del Mercurio," by V. Spirek, *Trans. Internat. Congress of Applied Chemistry, Rome* (1906, **2**, 340). The following is an estimate by V. Spirek of the cost in Europe of the plant necessary to treat 13,500 tons of ore per annum, to yield 160 tons of metallic mercury:

	Daily output.	Cost. £
1 continuous roasting furnace and condenser	16 tons	1,508
1 medium " " "	8 "	873
1 small " " "	2 "	198
1 double shaft furnace	18 " (both)	317
1 single " "		159
Muffle furnace	1 ton	357
Drying furnace		238
Central condensing chamber		397
Machinery		317
Buildings		1,587
		5,951

The cost of treatment in the Monte Amiata district is said to average 36·56*d.* per ton of ore, distributed as follows:

	Pence.
Furnace workers	6·55
Sifting of ore	3·23
Drying of ore and cost of transport	5·70
Supervision and packing	5·98
Fuel	12·25
Repairs, etc.	2·85
	36·56

The cost of mining in the Monte Amiata district is said to vary from 14*s.* to 23*s.* per ton of ore.

Properties and Uses of Mercury

Metallic mercury is a silver-white substance, liquid at temperatures above – 38° C. and boiling at 357° C. It has a specific gravity 13·6, and readily forms amalgams with gold, silver, bismuth, tin, lead, and zinc, at ordinary temperatures, and with many other metals on heating.

Mercury finds a wide application in the arts and manufactures. Probably the largest use at the present time is its employment in the gold industry for amalgamation purposes. Since the introduction of the cyanide process the consumption of mercury, in proportion to the gold recovered, has considerably diminished. At the present

time the average consumption of mercury per ton of gold ore treated varies from 0·2 to 0·3 oz. At first sight this would not appear to indicate a large demand, but when it is remembered that in the Transvaal alone during 1911 24,000,000 tons of gold ore were crushed, the magnitude of the demand for this purpose becomes obvious.

The metal is also used in the manufacture of mercury fulminate, the active ingredient in igniting and detonating mixtures for explosives. The value of mercury fulminate in this connection depends upon its great sensitiveness to friction and percussion. For most purposes mercury fulminate is too rapid in its action to be used alone, and it is therefore mixed with varying amounts of potassium chlorate and other substances. In detonators for industrial purposes gun-cotton is sometimes also added. The "service composition" for percussion caps of cordite small arms ammunition is stated to have the following percentage composition: mercury fulminate, 19·05; potassium chlorate, 33·33; antimony sulphide, 42·86; sulphur, 2·38; finely powdered gunpowder, 2·38.

Mercury is also used to make the pigment vermillion, a sulphide of mercury. The raw cinnabar is stated to be unsuitable for this purpose, as the impurities present affect the colour.

In medicine and surgery several salts of mercury find application. Amongst these may be mentioned the nitrate, chlorides, and iodide. Mercuric chloride (corrosive sublimate) is also employed in very dilute solutions as a fungicide.

A certain quantity of metallic mercury is employed in the manufacture of scientific instruments, and it is also used in the Chinese method of gilding. A small quantity is also consumed in the manufacture of the mercury-vapour electric lamp. Nitrate of mercury is stated to be sometimes employed in the manufacture of felt hats. An amalgam of mercury and tin is sometimes employed for "silvering" mirrors.

Statistics of Production and Trade

The following table shows the output of mercury in the chief producing countries:

	Metric tons. 1910.	Metric tons. 1911.	Metric tons. 1912.[2]
Austria-Hungary	603	685	675
Italy	893	815	823
Spain	1,000	1,055	1,035
China[1]	49	—	—
Mexico	200	95	112
United States	701	723	857

[1] *Exports only.* [2] *Estimated production.*

The following figures indicate the import and export trade in mercury in some of the chief countries where that metal is used. In converting the published figures into metric tons a flask has been taken as equal to 75 lb.:

	1910.		1911.	
	Import. *Metric tons.*	Export. *Metric tons.*	Import. *Metric tons.*	Export. *Metric tons.*
United Kingdom	1,520	843	1,587	1,071
France	146	—	196	—
Germany	836	31	919	36
India	160	2	106	2
Union of South Africa	129	—	108	—
Australian Commonwealth	57	—	41·5	—
Canada	129	—	59	—
United States	0·3	65	—	—

Commercial Value.—Mercury is sold and shipped in iron bottles (flasks) each containing about 75 to 76 lb. During recent years the average price has shown a slight upward tendency. The following table shows the prices in London during recent years:

	Highest. £ s.	Lowest. £ s.
1908	8 10	7 12
1909	9 17	7 19
1910	9 15	7 9
1911	10 0	7 0

The present price (August 1913) is £7 5*s.* per flask.

Specimens of mercury ore from the following localities are shown in the public exhibition galleries of the Imperial Institute:

New South Wales	Cudgegong near Rylstone; Yulgilbar, Clarence River District.
Queensland	Kilkivan.
Union of South Africa	Hector Spruit, Swaziland.
Canada	Kamloops, British Columbia; Barclay Sound, British Columbia.

THE COALS OF CANADA

During recent years extensive investigations have been made of the coal resources of Canada, and a considerable amount of literature has been published on this subject by the Department of Mines. The most important of these publications is *An Investigation of the Coals of Canada*, by J. B. Porter, R. J. Durley, and others, which embodies the results of work carried out at the McGill University, Montreal, under the authority of the Dominion Government. In view of the great importance of Canadian coal resources, an attempt has been made in the present article to summarise the information now available. At the end of the article is given a bibliography comprising the more important publications dealing with the coal resources of Canada.

The coal fields of Canada may be grouped in the four great divisions which, with their estimated contents of workable coal, are given below:

(1) *The Atlantic Provinces.*—Nova Scotia and New Brunswick:

Bituminous coal	3,500,000,000 tons

(2) *The Central Plains and the Eastern Rocky Mountains.*—Manitoba, Saskatchewan, Alberta, British Columbia:

Anthracite	400,000,000 tons
Bituminous coal	30,000,000,000 ,,
Sub-bituminous coal and lignite . .	100,000,000,000 ,,

(3) *The Pacific Coast and the Western Mountains.*—British Columbia and the Yukon:

Anthracite	61,000,000 tons
Bituminous coal	40,000,000,000 ,,
Lignite	500,000,000 ,,

(4) *The Arctic-Mackenzie Basin*:

Lignite	490,000,000 tons

There are also certain small fields in Ontario containing some millions of tons of lignitic peat, and others of doubtful extent and value in the far north.

Owing to shipping facilities and proximity to markets the Nova Scotian coal fields have hitherto been the most

productive. The Western fields, however, are rapidly developing, and will doubtless continue to do so as railway extensions open up new districts. The relative importance at the present time of the different areas is shown by the following table, giving the output by provinces for the last three years.

Province.	1910.		1911.		1912.	
	Production. Short tons.[1]	Value. $	Production. Short tons.[1]	Value. $	Production. Short tons.[1]	Value. $
Nova Scotia . .	6,431,142	12,919,705	7,004,420	14,071,379	7,791,440	17,391,608
British Columbia	3,330,745	10,408,580	2,542,532	7,945,413	3,220,899	10,065,311
Alberta . . .	2,894,469	7,065,736	1,511,036	3,979,264	3,446,349	8,471,126
Saskatchewan .	181,156	293,923	206,779	347,248	196,325	327,054
New Brunswick	55,455	110,910	55,781	111,562	42,780	85,560
Yukon Territory	16,185	110,925	2,840	12,780	2,160	8,640
Total . . .	12,909,152	30,909,779	11,323,388	26,467,646	14,699,953	36,349,299

[1] 2,000 *lb.*

In the following pages the coal fields of Canada are considered province by province, beginning with Nova Scotia and proceeding westward.

Nova Scotia

The coal-bearing measures of this province belong to the Carboniferous system, and are practically confined to the sub-division known as the Productive Coal Measures. All the coal is bituminous in quality. There are five distinct coal fields, known as the Sydney, Inverness, Richmond, Pictou, and Cumberland fields.

Sydney Coal Field.—The Sydney field is situated in the north-east corner of Cape Breton county, with the deep-water harbour of Sydney as its central point; it also takes in a small portion of Victoria county. It covers about 200 square miles of land, with important extensions beneath the ocean. The coal measures are largely composed of shales and sandstones, the solidity and coherence of which favour submarine exploration. The seams occur in a series of basins which are partially submerged; they dip seawards at angles of 5° to 12°, and are but little affected by faults and disturbances. The aggregate thickness of coal, in workable seams from 3 to 9 ft. thick, is 40 or 50 ft. The coal is well adapted for general purposes,

while some seams are specially suitable for the manufacture of gas. As compared with the Pictou coal it is characterised, on the whole, by a greater proportion of combustible matter and a smaller proportion of ash; but, on the other hand, it usually contains a greater amount of sulphur, only a part of which can be removed by washing. The following table shows the suitability of some of the Sydney coals for gas manufacture.

Mines.	Gas, cubic feet, per ton.	Candle-power of gas.	Coke produced, per ton.
Little Glace Bay	9,268	15	40 bushels
" " "	9,700	14·75	39 "
International	10,000	16	1,470 lb.
Sydney Mines	8,200	8	1,295 "
Gowrie Mines	9,000	15	1,230 "
Caledonia Mines	8,900	14·25	36 bushels
Reserve Mines	9,950	13·17	1,500 lb.

Inverness Coal Field.—In the Inverness field the coal measures comprise a series of narrow areas on a line extending from Judique to Margaree, along the western shore of Cape Breton Island. They appear as remnants of the rim of a basin, the greater part of which has been eroded. At Port Hood one seam, 6 to 8 ft. thick, is being worked, and another 6-ft. seam is reported to occur. Some ten miles farther north, near Mabou, a section is said to show six seams ranging from 3 to 15 ft. in thickness. Twelve miles farther north, at Port Ban, another narrow fringe of coal-bearing measures comes in, and continues with a few interruptions as far as Chetikamp, a distance of over 50 miles if measured along the coast. In several places there are good seams of coal which have been worked at various times, and one of which is being worked at present. Near Broad Cove, Inverness, for instance, seams of 3 ft., 5 ft., 7 ft., and 3 ft. 6 in. occur, dipping seaward at from 10° to 20°. At Chimney Corner the seams measure 3 ft., 5 ft., and 3 ft. 6 in.

Richmond Coal Field.—In Richmond county, in the south-western part of Cape Breton Island, a small development of coal measures occurs between the Strait of Canso and Inhabitants river. Coal seams of workable size are visible on the shore of Cariboo cove, at Sea-coal bay,

where they dip at 75° to the south-west. The principal seam is 11 ft. thick, inclusive of several bands of shale. The others are 4 ft. and 5½ ft. thick, the latter including a 15 in. band of fire-clay. At a point on Little river, about 3 miles north of the Cariboo cove outcrops, a 3-ft. and a 4-ft. seam have been proved. This area is very much disturbed, and dips of 85° occur.

Pictou Coal Field.—The Pictou field is situated in the centre of Pictou county, south of the town of New Glasgow. It extends 12 miles in an east and west direction, with a maximum breadth of 3 miles. It may be divided into three districts or sections, viz.: the Westville section on the west, the Stellarton or Albion section in the centre, and the Vale section on the east. The Westville division is separated from the adjacent one to the east by the McCulloch fault, the throw of which has been estimated at 2,600 ft. Four seams have been recognised: the Main or Acadia seam, 17 ft.; Second seam, 12 ft.; Third seam, 6 ft.; Fourth seam, 8 ft. The average strike is north-west and south-east, and the dip 16° to the north-east. The Stellarton or Albion section is remarkable for the great size of some of its seams. They are, in descending order, the Main seam, 38 ft.; Deep seam, 22 to 40½ ft.; Third seam, 12 ft.; Purvis seam, 3 ft.; Fleming seam, 5·6 ft.; McGregor seam, 15 ft.; Stellarton oil-coal, 5 ft. The general strike of the outcrops is more nearly east and west than in the preceding division, and the dip varies from 15° to 30° to the north. In the Vale division the coal measures take the form of a syncline. The known seams are: the George McKay 4-ft. seam, good coal 2 ft.; the Six-foot seam; the McBean seam, 8 ft.; and a small seam of 2 ft.

Cumberland Coal Field.—In Cumberland county there are two considerable areas of Productive Coal Measures, separated by a tract of newer rocks. One of these, the Springhill area, is situated near the middle of the county; it measures about 7 miles north and south by about 3 miles east and west, and the formation extends farther westward beneath the younger rocks. There are at least five workable seams in this field, ranging in thickness from 4 to 13 ft. The dip is steep, averaging from

25° to 30°, and reaching 75° in places. The other important section of the coal field is the Joggins area. Here the coal measures are exposed on the shores of Chignecto bay, an arm of the bay of Fundy, and stretch eastward for some 18 miles, with an outcrop about 2 miles wide and a dip to the south. The Productive Coal Measures are about 2,540 ft. thick and contain a great number of coal seams, most of which are very thin. Small seams also occur in the underlying Millstone Grit series. A third small area of coal measures lies to the north of the Springhill field, near Salt Springs station on the Intercolonial Railway.

Coals of Nova Scotia

	Fixed carbon.	Volatile matter	Ash.	Sulphur.	Moisture.	Calorific value.[1]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Sydney coal field.						
Gowrie seam, North Atlantic Collieries, Port Morien	53·0	34·7	12·3	6·4	2·8	7010
Hub seam, Dominion No. 7 Colliery, Glace Bay .	57·6	36·5	5·9	2·4	2·6	7700
do. do. do. washed coal	59·1	38·2	2·7	2·0	—	7950
Harbour seam, Dominion No. 9 Colliery, Glace Bay	55·5	38·6	5·9	3·7	1·6	7780
Phalen seam, Dominion No. 5 Colliery, Glace Bay .	59·5	35·0	5·5	1·8	1·9	7800
do. Dominion No. 1 Colliery, do. .	59·8	34·3	5·9	1·9	2·1	7780
Emery seam, Dominion No. 10 Colliery, Glace Bay	53·8	35·1	11·1	2·5	2·0	7290
do. do. do. washed coal	57·3	36·9	5·8	2·1	—	7710
Lingan seam, Dominion No. 12 Colliery, Glace Bay .	57·9	37·3	4·8	1·8	3·6	7660
Sydney Mines, No. 1 Colliery	55·4	37·4	7·2	2·9	2·7	7650
do. do. washed coal . .	56·3	40·2	3·5	1·9	—	8050
do. No. 3 Colliery	54·3	39·0	6·7	2·5	4·0	7600
Inverness coal field.						
Inverness Colliery	49·6	40·0	10·4	6·0	7·5	6750
do. washed coal	51·0	42·5	6·5	5·0	—	7110
Port Hood Colliery	48·3	37·1	14·6	7·9	3·2	6540
do. washed coal	51·2	37·9	10·9	6·7	—	6970
Pictou coal field.						
Six-foot seam, Vale Colliery, Thorburn . . .	50·6	32·1	17·3	1·0	2·1	6680
do. do. washed coal . .	54·2	33·2	12·6	1·0	—	7000
Foord seam, Allan Shaft Colliery, Stellarton . .	55·4	33·3	11·3	0·6	1·7	7350
Third seam, Albion Colliery, Stellarton . . .	55·5	29·8	14·7	1·4	2·0	6990
do. do. do. washed coal	56·9	30·8	12·3	1·0	—	7250
Cage Pit seam, Albion Colliery, Stellarton . .	58·1	31·4	10·5	0·9	1·9	7320
Main Seam, Acadia Colliery, Westville . . .	64·8	26·0	9·2	0·9	1·6	7700
do. Drummond Colliery, Westville . .	60·8	24·7	14·5	2·5	1·1	7200
do. do. do. washed coal .	63·4	25·3	11·3	1·3	—	7530
Springhill coal field, Cumberland county.						
No. 1 Colliery, Springhill	63·3	33·3	3·4	1·0	2·2	7880
No. 2 Colliery, do.	58·5	32·3	9·2	1·6	2·0	7430
do. do. washed coal . . .	59·8	33·1	7·1	1·4	—	7700
No. 3 Colliery do.	55·0	33·5	11·5	1·8	2·3	7220
do. do. washed coal . . .	57·0	34·7	8·3	1·5	—	7540
Joggins-Chignecto coal field, Cumberland County.						
Chignecto Colliery	45·7	41·0	13·3	6·4	3·2	6750
do. washed coal	49·6	41·3	9·1	6·2	—	7160
Minudie Colliery	48·8	35·7	15·5	6·7	2·8	6570
do. washed coal	51·7	37·3	11·0	6·3	—	7000
Joggins Colliery	41·8	36·6	18·6	5·4	0·6	6440
do. washed coal	51·6	38·1	10·3	4·8	—	7080

[1] *In this and the following tables the calorific values are from determinations made with the Köhler bomb calorimeter on coal dried at 105° C. They are given in gramme-degree Centigrade units (small calories) per gramme of coal burnt. All the samples represent the normal output of producing mines.*

New Brunswick

The Productive Coal Measures which occur in Nova Scotia appear to be absent from New Brunswick, where the coal seams are found in the slightly older Millstone Grit series.

In the Grand Lake area, Queen's county, the coal measures are nearly horizontal. Two coal seams occur, separated by a parting of varying thickness. The upper seam is about 20 in. thick, and the lower 10 in. They coalesce in certain places, and form a seam 30 in. thick. The coal occurs quite near the surface, the deepest shafts not exceeding 40 ft. in depth. There are numerous small mines in the field. The coal is mined either by stripping the overburden, or by driving levels from the bottom of a shaft. When the levels reach a length of 400 or 500 ft. the practice is to move the whole plant, and sink a new shaft some 1,000 ft. from the old one in order to minimise underground haulage.

Mining on a small scale has been carried on near Beersville, in Kent county, on a seam about 20 in. thick. At Dunsinane, on the Intercolonial Railway about 30 miles south-west of Moncton, several drifts have been made in a seam 18 to 20 in. thick.

Coals of New Brunswick

	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Moisture.	Calorific value.
Grand Lake coal field	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories*
King's Mine, Minto . . .	53·4	32·2	14·4	5·8	0·9	7160
do. do. washed coal	56·6	34·0	9·4	4·9	—	7680

Ontario

In the northern part of Ontario beds of low-grade lignite occur in clays and shales of Glacial age. These stratified deposits appear to have been formed during an interglacial period, and to have suffered severe erosion on the return of the ice. They are particularly well developed in the Moose River basin, and although they are too

remote to be of any present economic value they constitute fuel assets which may become important in the future.

Manitoba and Saskatchewan

No coals of Carboniferous age are known in the western half of Canada. There the coal-bearing beds belong chiefly to the Cretaceous system and to the Laramie formation, which may be regarded as its upward continuation. Jurassic and Tertiary coals occur in a few localities. Cretaceous beds first appear a little to the west of Winnipeg, whence they extend without interruption to the Rocky Mountains; but coal occurrences are few and of comparatively little importance until Alberta is reached.

The most easterly of these coal-bearing areas is that of Turtle Mountain, in Manitoba. This is situated near the intersection of the 100th meridian with the International Boundary, the southern half of the area being in North Dakota. Turtle Mountain is composed of sandy beds belonging to the Laramie formation. Seams of lignite occur at various points, and have been worked for local use. The lignite disintegrates on drying, and will not stand long transportation.

Laramie beds cover some 4,000 square miles in the southern part of Saskatchewan, and cross the International Boundary into North Dakota. Lignite seams are numerous, but, owing to the character of the country, and to the thick covering of superficial deposits, their study is difficult, and very little is known of the possibilities of the area beyond the Souris river district. Here, in the neighbourhood of Estevan, the seams are exposed in the river banks. They occur at three horizons. In the upper one the main seam is 4 ft. thick, locally thickening to 8 ft., but the lignite is of rather inferior quality. The middle horizon is characterised by a very variable seam, ranging from 2 to 6 ft. in thickness, sometimes split into three seams. In some places this is separated from the coal of the upper horizon by 40 to 60 ft. of indurated clay and sand; at others, the two seams come together. The lower horizon, about 50 ft. below the middle one, contains several seams which in

places come together, and form a seam 8 ft. thick. This lignite is of better quality than that of the overlying seams, but contains much water and disintegrates after a comparatively short exposure to the air.

Two seams of low-grade lignite, 3 ft. and 5 ft. thick, are exposed on Big Muddy creek near the International Boundary. An 18 ft. seam occurs on the Poplar river. At Wood Mountain seams of 6 ft. and 5 ft. have been opened. Lignite is also exposed at Willowbunch, and further west a 4 ft. seam is recorded in the Cypress hills.

Lignites of Saskatchewan

	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Moisture.	Calorific value.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Souris River coal field.						
Western Dominions Collieries, Taylorton . .	42·9	49·0	8·1	0·6	18·0[1]	5940
Eureka Coal and Brick Co., Estevan . .	43·2	40·0	16·8	0·5	18·2[2]	5360

[1] *Before air-drying*, 28·6. [2] *Before air-drying*, 30·9.

ALBERTA

The principal coal-bearing horizons in Alberta are, in descending order, the Edmonton, Belly River, and Kootanie formations, all of which belong to the Cretaceous system. The overlying Paskapoo series (Tertiary) contains a few seams of lignite, which are worked for local use, but these are of comparatively little importance.

Edmonton Formation.—The Edmonton series forms a gentle trough, the axis of which runs roughly parallel with the Rocky Mountains, and covers an area of some 35,000 square miles. The upper part generally contains lignite in seams up to 25 ft. thick.

At Edmonton a seam varying from 3½ to 6 ft. is extensively worked, mainly for domestic purposes. The seam is practically level. At Strathcona two seams, 5 and 6 ft. thick, are worked. Near Morinville there is a thickness of 12 ft. of lignite, with a parting from 6 in. to 2 ft. thick in the middle. A 5-ft. seam is worked at Diamond City.

Numerous outcrops of lignite have been recorded, as on the Bow river, on Red Deer river at several points, at Buffalo lake, on Battle river, on the Athabaska, Pembina, Brazeau, and Saskatchewan, and east of the Porcupine hills.

Belly River Formation.—The Belly River coal formation is separated from the Edmonton coals by a vertical thickness of 1,000 ft. of shales. Its outcrop covers 18,000 or 20,000 square miles in southern Alberta and in Saskatchewan, to the east of the Edmonton series. The fuel is lignite, but of better quality than that of the Estevan district.

At Taber, 75 miles west of Medicine Hat, a horizontal seam containing 41 or 42 in. of clean coal is mined at a depth of 100 ft. The seam worked at Lethbridge gives 4 ft. of coal, with a parting 2 to 6 in. thick in the upper part. At Lundbreck, 75 miles west of Lethbridge, the beds are rather disturbed. At one mine a seam 9 ft. thick, dipping at 60° to 80°, is being worked. Several outcrops are known in the neighbourhood of Medicine Hat, and also on the Belly, Bow, and Red Deer rivers, and near Irvine station. In the foothills this formation reappears from under the younger rocks, and workable seams occur south of Morley station, on the Jumping-pond and Elbow rivers, and on Sheep creek. Farther north, in the Peace river country, there are two areas of these beds, but the seams are mostly thin except across the boundary in British Columbia.

Kootanie Formation.—The Kootanie coal formation, at the base of the Cretaceous system, is only known to reach the surface in the disturbed region of the Rocky Mountains, and the foothills to the east of them. Here it occurs in a series of troughs and fault blocks separated by outcrops of older rocks. It contains seams varying in quality from coking and non-coking bituminous coals to anthracites with 85 per cent. or more of fixed carbon. The amount of volatile matter appears to depend on the degree of disturbance the beds have undergone.

The Blairmore-Frank coal field is situated in the south-western part of Alberta, on the Crowsnest branch of the

Canadian Pacific Railway. It includes several troughs of coal-bearing rocks, separated by north and south faults, and by ridges of older rocks. In a section measured in the northern part of the field the coal measures have a thickness of 742 ft., and contain seven seams over 8 ft., six seams between 5 and 8 ft., and eight seams under 5 ft. Another section in the southern part of the field shows nine seams from 8 to 16 ft. thick in 480 ft. of measures. The coal, as a rule, is a good coking coal, though rather high in ash. Several collieries are operating within 5 miles of Frank. At the Maple Leaf and Leitch collieries the seam worked is 7 ft. thick. At the Hillcrest mine a seam from 12 to 20 ft. thick, dipping at 30° to the west, is worked. At the Lille colliery two seams are worked, 4½ and 8 ft. thick, dipping at 35°; at this colliery there is a washing plant, and fifty coke ovens of the Bernard type. The Canadian American Coal Company work a colliery at Frank on the slope of Turtle Mountain; the seam ranges from 10 to 20 ft. in thickness, and is almost vertical. At the Denison mine, near Coleman, the seam known as No. 2 yields 12 to 14 ft. of good steam coal, and is separated by 150 ft. of strata from No. 4 seam, 6 to 8 ft. thick. The coal from this seam is used for the manufacture of coke, for which purpose 176 beehive ovens have been built.

The Canmore and Cascade Mountain coal areas are near Banff on the main line of the Canadian Pacific Railway. The coal measures form a narrow band in which the dips are to the south-west at from 30° to 50°. At Canmore, 14 miles south-east of Banff, five seams are worked, having the following thicknesses: No. 2 seam, 6 ft.; No. 3 seam, 5 ft.; No. 6 seam, 5 ft.; No. 1 seam, 4 ft. 6 in.; No. 4 seam, 4 ft. At the Bankhead mine, 3 miles north of Banff, eleven seams are cut by a tunnel driven into the west slope of the valley of the Cascade river. The coal of the lowest seams is very near anthracite in composition and physical character, while in the upper seams the fixed carbon gradually diminishes and the volatile matter increases. The coal requires sizing and screening, and the dust is made into briquettes with coal tar pitch as a binder. Anthracitic coal

was formerly mined at Anthracite, 3 miles south-east of Bankhead.

Coal seams also occur in the Kootanie beds of the Livingstone, Moose Mountain, Palliser, Costigan, Sheep Creek, and Bighorn areas.

Coals and Lignites of Alberta

	Fixed carbon.	Volatile matter	Ash.	Sulphur.	Moisture.	Calorific value.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Edmonton coal field.						
Strathcona Coal Co., Strathcona	47·6	41·0	11·4	0·4	18·2	5960
Parkdale Coal Co., Edmonton	51·3	37·8	10·9	0·4	18·9	6060
Standard Coal Co., do.	49·9	42·0	8·1	0·4	19·8	6310
Belly River coal field.						
Canada West Coal Co., Taber	49·9	36·0	14·1	1·4	11·7	6130
Galt Colliery, Lethbridge	51·5	37·5	11·0	0·8	7·9	6510
Lund-Breckenridge Coal Co., Lundbreck	40·2	30·1	29·7	1·2	3·8	5450
Blairmore-Frank coal field.						
Leitch Colliery, Passburg	55·1	27·0	17·9	0·6	1·0	6800
Hillcrest Colliery, Hillcrest	55·4	29·3	15·3	0·6	1·3	6920
do. do. washed coal	60·4	29·8	9·8	0·5	—	7450
No. 1 seam, Bellevue Colliery	56·9	27·6	15·5	0·8	0.2	6880
do. do. washed coal	58·9	28·4	12·7	0·5	—	7210
No. 1 seam, Lille Colliery	58·6	25·0	16·4	0·5	0·8	6930
No. 2 seam, Denison Colliery, Coleman	55·1	25·1	19·8	0·4	0·7	6510
do. do. do. washed coal	62·0	26·4	11·6	0·4	—	7320
No. 4 seam do. do.	59·9	23·9	16·2	0·6	0·6	6960
Cascade coal field.						
No. 1, or Old Mine, Canmore	70·5	17·2	12·3	0·8	0·9	7340
do. do. washed coal	77·9	16·2	5·9	0·7	—	8000
Bankhead Colliery, pea coal	76·0	11·8	12·2	0·6	0·5	7400
do. buckwheat No. 1	71·5	12·6	15·9	0·6	0·5	7040
do. mixture of pea and buckwheat No. 1	73·3	12·6	14·1	0·6	—	7270
do. coal dust briquettes	68·6	17·1	14·3	0·6	0·9	7280

BRITISH COLUMBIA

The coal fields of British Columbia fall into three groups, viz., the Rocky Mountain fields in the east, a central group including the Princeton, Nicola, and Telkwa Valley fields, and the Vancouver and Queen Charlotte Islands fields in the west.

The Crowsnest Pass coal field is situated immediately to the west of the summit of the Rocky Mountains, in Crowsnest Pass, a small portion crossing the watershed into the province of Alberta. The Crowsnest branch of the Canadian Pacific Railway crosses the northern part of the field and skirts its western edge for a distance of 25 miles, and the district is also served by the Great Northern Railway. The

field has the form of a flat-bottomed basin of Cretaceous rocks resting on limestones of Devono-Carboniferous age. The Crowsnest Coal Measures, which belong to the Kootanie series, have a thickness of 1,850 ft. near Morrissey, and contain 198 ft. of coal, of which at least one-half is workable. The opening of this coal field has been of the greatest importance to the smelters of southern British Columbia, and has reduced the cost of fuel to about one-half. At Coal Creek, 5 miles from Fernie, the seams are worked by tunnels driven on either side of the valley. Besides being used on the railways and for domestic purposes in British Columbia, Alberta, and Washington, the coal is largely converted into coke for metallurgical use. For this purpose 454 beehive coke ovens are at work, with a capacity of 643 tons per day. At the Michel colliery, 24 miles north of Fernie, the coke oven plant consists of 486 beehive ovens, with a capacity of 688 tons of coke per day. The Hosmer mines, 8 miles north of Fernie, are worked by tunnels which cut thirteen seams, from 4 to 30 ft. thick. The coke oven plant can produce 300 tons per day. The Corbin Colliery, near the centre of the field, works one seam which is 40 ft. thick in places and dips at 70° to the east.

Immediately to the north of the Crowsnest Pass basin, but separated from it by a belt of the underlying limestones, there is another trough of coal-bearing Cretaceous rocks. This extends northward along the Elk river for some 50 miles, to the Kananaskis Pass. At one point twelve seams were observed, from 8 in. to 35 ft. in thickness, and a railway running northward from Michel would enable large deposits of coal to be exploited. An average of eight analyses of coal samples from Aldridge creek, a tributary of Elk river, shows 67·3 per cent. fixed carbon, 25·6 per cent. volatile combustible matter, and 7·2 per cent. ash.

The Princeton coal field is situated at the junction of the Tulameen and Similkameen rivers in southern British Columbia. Seams of high-grade lignite occur in sandstones and shales of Tertiary age. A bore hole at Princeton showed an 18-ft. seam 49 ft. below the surface, and seams

outcrop at various places on the banks of the rivers. A sample from the large seam at Princeton gave on analysis 41·67 per cent. fixed carbon, 37·58 per cent. volatile combustible matter, 4·58 per cent. ash, and 16·17 per cent. moisture.

There are a number of promising outcrops of bituminous coal in the hills on the southern bank of the Tulameen river between Granite creek and Otter Flat, about 12 miles west of Princeton. One of the seams produced excellent coke when tested in Belgian ovens. Samples from one of these seams gave the following range of results on analysis: Fixed carbon 54·0 to 51·9; volatile matter 33·7 to 32·1; ash 12·3 to 16·0; moisture 2·3 to 3·2 per cent.

The Nicola Valley coal field lies to the south of Nicola lake in the Kamloops district. The seams occur among greyish sandstones and shales of Tertiary age. Mines have been opened on various seams near Coutlee. The Diamond Vale seam, at the top of the series, is 4 ft. 6 in. thick, with a parting of about 12 in. The Rat Hole seam is 6 ft. thick, the Gem seam 3 ft., the Major seam 17 ft. 6 in., the Ells seam 9 ft., and the Jewel seam is in two benches of 9 ft. and 5 ft. 6 in., with a parting of 2 ft. 6 in.

The Telkwa Valley Coal Field.—Further north, in the Skeena river country, the Telkwa Valley coal field will probably soon become important on the construction of the projected line of the Grand Trunk Pacific Railway. The rocks of this district are, in ascending order, (1) the crystalline rocks of the Coast range, (2) a great thickness of volcanic rocks, (3) the coal-bearing beds, chiefly shales, (4) a series of newer eruptive rocks. There is some evidence that the coal-bearing series is of Lower Cretaceous age. Owing to the soft and easily eroded nature of these beds, and the considerable folding and faulting they have undergone, their outcrop is confined to a few isolated patches. In places four seams have been uncovered, from 4 to 7 ft. in thickness, contained in a few hundred feet of measures. The character of the coal varies from bituminous to semi-anthracitic, analyses showing the following range of composition: Fixed carbon 56·90 to 82·70; volatile combustible matter 30·45 to 10·80; ash 5·90 to 9·20; moisture 0·58 to 6·60 per cent.

Vancouver Island.—Here coal-bearing Cretaceous beds outcrop in a long, narrow strip occupying most of the southern half of the east coast. On the west they abut against the old crystalline rocks, and on the east they dip beneath the Strait of Georgia. A break some 12 miles long at Nanoose Bay divides the strip into two portions, the Nanaimo field in the south and the Comox field in the north. A third area is the Suquash field near Alert Bay, 125 miles north of Comox.

Near Nanaimo the seams worked are the Douglas, 7 to 10 ft., the Newcastle, 2½ to 8 ft., and the Wellington seam, 4 to 14 ft. thick. The general dip is about 10°.

In the Comox field four mines are situated near the town of Cumberland, 13 miles from the shipping wharves at Union Bay. The seams vary from 3 to 8 ft. in thickness. A coal-washing plant is installed, and also a battery of 100 beehive coke ovens.

The Suquash field is not at present producing, but borings have proved a very constant 5-ft. seam at 172 ft. from the surface, with two other seams at about 900 ft. A shaft has been sunk to the first seam and a slope driven under the sea following the dip.

Queen Charlotte Islands.—The most important coal-bearing area known in these islands is found in a development of Cretaceous rocks on Graham Island, the most northerly of the group. Here coal outcrops occur at several places between Skidegate channel and Yakoun lake. At Camp Wilson the seam measures 17 ft. 6 in., with a parting of 6 in. to 1 ft. of sandstone, and dips at 75° to the north-east. Nine miles to the south, at Camp Robertson, there appear to be two seams, the upper containing 6 ft. 3 in. of coal and the lower about 8 ft., with shale partings in each case. The outcrop at Camp Anthracite appears to be on the same line of strike as the Camp Robertson seam, at about 1 mile to the south-east of it. The shale and coal are much broken, and the latter is of poor quality. The coals of Graham Island vary much in character, the fixed carbon ranging from 46·01 to 80·07 per cent.; but the percentage of ash is high, as in most of the Pacific coast coals.

Coals and Lignites of British Columbia

	Fixed carbon.	Volatile matter	Ash.	Sulphur.	Moisture.	Calorific value.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small Calories.*
Crowsnest coal field.						
No. 3 Mine, Michel Colliery	62·7	24·8	12·5	0·5	0·4	7370
do. do. washed coal	68·6	25·2	6·2	0·5	—	7950
No. 7 Mine, do.	65·5	22·6	11·9	0·4	0·7	7420
No. 8 Mine, do.	65·7	24·1	10·2	0·6	1·1	7490
No. 2 seam south, Hosmer Mines	63·4	21·3	15·3	0·3	0·9	7060
No. 6 seam south, do.	62·0	25·6	12·4	0·6	1·1	7270
No. 8 seam south, do.	64·5	28·0	7·5	0·6	1·3	7770
No. 2 Mine, Coal Creek Colliery, Fernie	64·7	26·3	9·0	0·5	1·3	7680
No. 5 Mine, do. do.	65·2	24·0	10·8	0·5	0·5	7490
Nicola Valley coal field						
Jewel seam, Middlesboro Colliery, Coutlee	46·4	39·1	14·5	0·9	3·9	6490
Rat Hole seam, do. do.	48·1	39·0	12·9	0·7	2·3	6760
Mixture of the last two, washed coal	50·2	39·8	10·0	0·9	—	7010
Nanaimo coal field, Vancouver Island						
Wellington seam, Extension Mine	49·8	40·1	10·1	0·4	1·1	7310
Upper seam, No. 1 Mine, Nanaimo	48·5	41·2	10·3	0·9	1·6	7130
Lower seam, do. do.	46·6	41·5	11·9	1·3	1·9	6930
Comox coal field, Vancouver Island.						
Lower seam, No. 4 Mine, Cumberland	56·5	31·6	11·9	1·0	—	7150
do. No. 7 Mine, do.	60·1	28·0	11·9	0·9	—	7210
Mixture of the last two, washed coal	60·3	30·8	8·9	0·8	—	7550
Suquash coal field, Vancouver Island.						
Suquash Mine, Alert Bay,	42·7	34·3	23·0	1·0	7·0	6170[1]
do. do. washed coal	48·2	36·7	15·1	0·9	5·3	6420[1]

[1] *Determinations made with Parr calorimeter. These two samples were taken during development work and showed signs of surface weathering.*

Yukon Territory

Coal and lignite occur extensively in Yukon Territory. Three of the most important localities are the Whitehorse, Tantalus, and Rock Creek coal areas. In the first two the coal measures occur mainly in the Tantalus Conglomerate and to a less extent in the upper part of the underlying Laberge series, and are of Jura-Cretaceous age. In the more northerly Rock Creek area the coals are all lignites, and occur in beds of Tertiary age.

The Whitehorse coal area is situated about 12 miles to the south-west of Dugdale, a siding on the White Pass and Yukon Railway. Three seams outcrop at the head of Coal creek, measuring 9 ft. 8 in., 10 ft. 4 in., and 2 ft. 6 in. in thickness. The coal is anthracitic. A sample from the first seam, taken at 60 ft. from the outcrop, gave the following percentage results on analysis: Fixed carbon 69·86, volatile combustible matter 6·01, water 2·15, ash 21·98.

Tantalus is situated on the Lewes river, 105 miles from Whitehorse, in a direction slightly west of north. The

coal area extends along the Lewes and Nordenskiöld rivers, with a detached portion farther south known as the Braeburn-Kynocks coal area. The latter lies due west of the northern end of Lake Laberge. The upper coal horizon occurs near the top of the Tantalus Conglomerate, and includes the seams at the Tantalus mine and at Tantalus butte. These seams contain plant remains of Kootanie type. At the Five Fingers mine and in the Braeburn-Kynocks area the seams occur in the lower coal horizon, the upper part of the Laberge series. The coals range from high-grade lignites to coking bituminous coals; they are used principally by the river steamboats, but they yield a good coke in the laboratory and will probably be used for smelting when the copper deposits of Whitehorse and the minerals of other parts of the Yukon become further developed. At the Tantalus mine the upper seam is 3 ft., the middle 6 ft. 6 in., and the lower 7 ft. 6 in. thick. Thin shale partings occur, and the percentage of ash is high. The quality of the output could be improved by sorting, but the cost of labour is prohibitive. At Tantalus butte, on the opposite bank of the river, the best seam contains 5 ft. of good coal, which gave the following percentage results on analysis: Fixed carbon 53·51, volatile combustible matter 32·28, water 9·48, ash 4·73. The Five Fingers mine is on the right bank of the Lewes river, about 16 miles below Tantalus. The seams vary in thickness and dip at 16° to the east. One seam gives 22 in. of coal of the following percentage composition: Fixed carbon 45·16, volatile combustible matter 40·46, water 5·95, ash 8·43. In the Braeburn-Kynocks area several seams of high-grade lignite occur. A surface-sample from an 8-ft. seam contained: Fixed carbon 42·56, volatile combustible matter 34·28, water 12·02, ash 11·14 per cent.

The lignite-bearing Tertiary beds of the Rock Creek area form a strip some 70 miles long between the Ogilvie range and the Klondike and Yukon rivers. At the southern end of the area coal seams outcrop on Coal creek, a tributary of Rock creek, which flows into the Klondike some 12 miles from Dawson. Two seams, 3 ft. and 2 ft. 3 in. thick, were at one time mined for use in Dawson. The

upper seam has the following percentage composition: Fixed carbon 40·88, volatile combustible matter 34·96, water 18·31, ash 5·85. A second Coal creek flows into the Yukon river 50 miles below Dawson. Several seams, from 4 to 20 ft. in thickness, are mined at a point 12 miles from the mouth of the creek, and it is proposed to erect a plant near the mine to supply electrical power to Dawson. At Cliff creek, which enters the Yukon 55 miles below Dawson, a seam was formerly mined which contained 11 ft. of lignite with several clay partings. Lignite from the upper part of the seam gave the following results on analysis: Fixed carbon 45·77, volatile combustible matter 42·02, water 8·57, ash 3·62 per cent. Other coal outcrops in this area are known at Twelvemile creek, Fifteenmile creek, and elsewhere.

Coals of the Yukon Territory

	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Moisture.	Calorific value
Tantalus coal field.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Small calories.*
Upper seam, Tantalus Mine . . .	58·0	25·0	17·0	0·5	—	6700
Do., do., washed coal	59·9	26·3	13·8	0·5	—	7110
Middle seam, Tantalus Mine . .	54·1	26·7	19·2	0·5	—	6310
Do., do., washed coal	60·3	25·7	14·0	0·4	—	7070
Lower seam, Tantalus Mine . . .	56·0	27·8	16·2	0·5	—	6790
Do., do., washed coal	59·2	28·1	12·7	0·5	—	7210

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GENERAL NOTES

Cotton Protection Ordinance in Nyasaland.—Great efforts are being made in Nyasaland to protect the agricultural industries from the introduction of plant pests from other countries, and an account of the rules made under the Plants Protection Ordinance was given in this BULLETIN (1913, **11**, 334). There is also a separate Cotton Ordinance, enacted in 1910 (cf. this BULLETIN, 1910, **8**, 431), and a set of rules made under this was published in the *Nyasaland Gazette* of January 31, 1913. These rules are designed to aid in combating pests by enforcing the burning of old bushes, and by bringing the seed sown under control, to maintain the quality and characteristics of Nyasaland cotton, and thus enhance the good reputation which the product has already acquired in the market.

They are to the following effect: All cotton bushes are to be uprooted and burnt before the last day of October following the date of planting, except in the Lower Shire, Ruo, and West Shire Districts, where they must be burnt before the last day of December. If this is not done the landowner and the persons who planted the bushes are liable to penalties, and the bushes may be uprooted and burnt at their expense. All cotton grown by natives upon Crown lands from seed issued by the Government is to be ginned in the Protectorate, and the Government has a right to the seed obtained from it on ginning. Such seed may only be sold or disposed of, if the Government does not need it. No cotton seed is to be issued to natives until it has been approved by the Director of Agriculture. Only persons authorised by the Governor are to distribute seed to natives for cultivation on Crown lands, and only persons who have obtained licences are allowed to purchase cotton grown by natives from seed distributed for cultivation on Crown lands. These licences are obtainable from the district residents for a fee, and are only valid till the following 31st of March, and for the place stated in the licence. Cotton markets are to be established by Government in native cotton-growing districts, and certain market-tolls are to be paid by the purchasers. The licensees are to make monthly returns showing the weight and price of the native-grown cotton from Crown lands that they have purchased, and are to allow the cotton to be inspected and to give information about its origin when required.

Cotton Growing in French Colonies.—The efforts which have been made during recent years to develop a cotton growing industry in the French Colonies have been referred to in several previous issues of this BULLETIN (1904, **2**, 122; 1908, **6**, 288; 1910, **8**, 61; 1912, **10**, 657). At the annual meeting of

the Colonial Cotton Association in March 1913, a report was made of the progress effected during 1912, and this has been published in the *Bulletin de l'Association Cotonnière Coloniale* (1913, **11**, No. 56).

An endeavour is being made to determine the possibilities of cotton production in the Morocco Protectorate, with the hope of enabling an industry to be established which would be of direct benefit to the natives.

The climatic conditions in Algeria in 1912 were unfavourable. In the East, protracted droughts occurred, whilst on the Oran side of the country the ripening of the cotton was affected by insufficient heat in the summer, and by the intervention of rain just at the time of gathering the crop.

In Tunis, efforts to produce a sufficient quantity of selected seed for distribution to growers were continued, and in spite of unfavourable weather, about 5,500 lb. of seed were obtained and placed at the disposal of the planters for the following season.

In Dahomey, experiments are being made to ascertain the yields obtainable from cotton grown on different kinds of soil, and to determine the behaviour of different varieties from the point of view of their suitability for cultivation and the value of their produce. It is anticipated that the projected extension of the railway systems in West Africa will give a considerable impetus to cotton production in Dahomey, especially in the densely populated regions of Jugu and Paraku.

Steady progress is being made in the French Sudan, and it is anticipated that the output in 1912–13 will reach 100 tons. The difficulty of transport is a great obstacle to the industry, but it is expected that when the railway has been constructed from Thies to Kayes the economic conditions of the country will undergo a complete transformation. Trials have been made in Senegal and the French Sudan in growing cotton under irrigation, and have met with considerable success.

The Governor of the Ivory Coast is convinced that cotton will become one of the most important resources of the natives of that country and will lead to a considerable increase in the export trade. A ginning factory has been erected at Bwake, and a study has been made of the local varieties of cotton.

The Association has also installed ginning machinery in New Caledonia and the New Hebrides. The cotton which is being produced is of very satisfactory quality, and spinners have expressed their readiness to purchase it at a price approximating to that of "good fair" rough Peruvian.

The total quantity of cotton produced in 1912, under

the auspices of the Colonial Cotton Association, amounted to 608·5 metric tons as compared with 460·8 metric tons in 1911. The amounts furnished by the different Colonies were as follows:

	1911. Metric tons.	1912. Metric tons.
Senegal	15	20
Upper Senegal and Niger region	60	100
Dahomey	135	125
New Caledonia	76	165
Madagascar	2·8	3·5
Tahiti	7	15
Algeria	165	180
	460·8	608·5

Balanites spp. from Portuguese East Africa.—In a recent number of this BULLETIN (1912, **10**, 548) an account was given of the fruits and oil of a new species of Balanites found in the Lebombo Mountains and on the banks of the Umbeluzi river in Portuguese East Africa. Herbarium specimens of the tree yielding these fruits have been examined at the Royal Botanic Gardens, Kew, and a description of the tree, under the name *Balanites Maughamii*, Sprague, appears in *Kew Bulletin* (1913, p. 131), together with that of a second new species, *B. Dawei*, Sprague, also from Portuguese East Africa. In addition to the localities mentioned above, *B. Maughamii* has been found in the Madenda Forest, where it is known by the native name "Manduro." Specimens have also been collected from near the Rovuma river. The tree reaches a height of 50 ft., and possesses an irregularly shaped bole up to 1⅔ ft. in diameter. The short, flower-bearing shoots are spineless, or almost so, but long, barren shoots, bearing forked spines up to 2¾ in. in length, also occur. The latter character serves to distinguish the tree from all other species of Balanites, except *B. Wilsoniana*, which possesses, however, much larger, ellipsoidal fruits, 4½ in. long and 3 in. in diameter, as compared with 1½ to 1¾ in. long, and 1 in. or rather more in diameter, in the case of *B. Maughamii*. *B. Dawei* also possesses two kinds of shoots, but spines are absent; the fruit of this species is sub-cylindrical in shape, and 2½ to 3 in. long. As was pointed out in this BULLETIN (*loc. cit.*), the difficulty and expense of removing the sugary pulp from the fruit, cracking the shells, and removing the kernels, would prevent the industrial utilisation of the fruits of *B. Maughamii*, and the same remarks no doubt apply also to those of *B. Dawei*.

Mineral Survey of Mozambique.—In 1911 a mineral survey of the territory of the Mozambique Company in Portuguese East Africa was established in connection with the Imperial Institute. The principal purpose of the Survey is to make

a comprehensive general exploration and examination of the mineral resources of the territory, in order to facilitate the detailed exploration of promising areas by private enterprise, with a view to the commercial development of such areas. The work of the Survey is naturally only in the initial stage, and it is not yet possible to make a complete report on the mineral resources of the country. The main features of the work accomplished in the first two seasons has, however, been made known by the publication of a Mineral Survey map, accompanied by a brief explanatory account of the country so far examined, together with a series of photographs and a small-scale map of the whole of the Mozambique Company's territory. The Mineral Survey map is on a scale of about 14 miles to the inch, and embraces a strip of country along the western boundary between the Morungueze river and Macequece. The chief geological features are indicated, as well as the localities where gold, coal, tin, graphite, and monazite have been observed. It is pointed out, however, that the indications as to the occurrence of particular minerals given on the map are not to be taken as meaning that these minerals occur in payable quality or quantity; their occurrence is only recorded as a guide for detailed exploration. Gold has been found to be widely distributed in small quantities in many of the streams, the best prospects being obtained along the Little Musapa river, a tributary of the Lucite river. Coal was found in the Mamoice district, but boring is necessary to determine whether payable coal occurs. Monazite occurs in small quantities in some of the stream beds, but tin ore has not been found so far in any quantity. Highly graphitic schist was found in the Mpunga and Mutanda districts, but no solid veins of graphite have yet been met with.

Copies of the Mineral Survey Map can be obtained without charge on application to the offices of the Mozambique Company at Thames House, Queen Street Place, London, E.C.

Oil Possibilities in South Australia.—It has been repeatedly rumoured that there are indications of the occurrence of petroleum deposits in Kangaroo Island and the western coast of Eyre's Peninsula in South Australia. These rumours have been based on the discovery from time to time of lumps of asphalt on the beaches in this region. The persistence of these rumours, and the recent developments in the uses of petroleum, have roused considerable public interest in South Australia, and the Government Geologist has recently visited the region for the purpose of making a rapid geological examination of those portions of it where discoveries of asphalt have been made.

The results of his investigation have been published as *Bulletin* No. 2, 1913, *Geol. Surv., South Australia.* He reports

that in both districts there is a fundamental and folded complex of ancient rocks, over a large part of which there is spread a thin mantle of sediments, probably of recent age. The sediments lie in approximately horizontal beds, and consist chiefly of loosely aggregated calcareous sand, with some marly beds. An examination of numerous sections showed that there are no continuous argillaceous beds.

No trace of any rock impregnated with bitumen was found, and in no case has any of the reported discoveries of veins of asphalt *in situ* been confirmed by a competent authority. "Fœtid limestones" occur on the shore of Murray's Lagoon, but their odour was found to be due to sulphuretted hydrogen, and they contained no trace of petroleum or petroleum derivatives. Moreover, the geological structure is not favourable for the accumulation of oil.

The Government Geologist is of opinion that the substance coorongite (elaterite or mineral caoutchouc), which has been found in appreciable quantities on the western shore of Murray's Lagoon in Kangaroo Island, is indigenous to the Island, but that it is not a petroleum product. Similar material is found on the mainland at localities where prospecting operations for oil have had negative results.

As regards the blocks of black bitumen or asphalt found on the beaches, there appears to be no doubt that these are petroleum products; but with reference to their place of origin the Government Geologist agrees with his predecessor that they are erratics, and that they have been drifted on to the beaches by ocean currents from some unknown source. Such occurrences have been reported from other parts of the south coast, and one has been found as far west as Bunbury in Western Australia. On some portions of the coast blocks of "kerosene shale" have been found, identical in appearance with that occurring in New South Wales. It is supposed that these also have been drifted on to the coast by ocean currents, after having been dropped in the sea by passing steamers.

The Government Geologist concludes that the various discoveries hitherto made are of no economic significance, and that they give no indication of the existence of oil-bearing deposits on either Kangaroo Island or Eyre's Peninsula.

Mineral Production of Quebec.—According to the *Report on Mining Operations in the Province of Quebec during the year* 1911, the total value of the mineral output for that year was \$8,679,786, an increase of \$1,356,505 as compared with the output of the previous year. The output during the period from 1899, when it had a value of only \$2,083,272, to 1911, shows an almost unbroken record of yearly increases,

which gives indication that the mining industry is built on a well-established basis, and gives promise of a steady future increase.

The chief item in the output was asbestos, the shipments of which reached a total of 102,224 tons, valued at $3,026,306, compared with 80,605 tons, valued at $2,667,829, in 1910. Though the shipments for 1911 were higher than those for 1910, the total quantity of rock mined was less, being 1,759,064 tons in 1911, as compared with 2,035,705 in 1910, the excess in shipments having been drawn from stock in hand. The centres of asbestos mining are Thetford mines, Black Lake, Danville, and East Broughton, all in the Eastern Townships. The growth of the asbestos output in Quebec may be judged from the fact that it was only 21,408 tons, valued at $719,416 in 1900, since when there has been a continuous increase.

A further increase took place in the output of pyritous copper ore, the amount shipped being 38,554 tons, valued at $240,097, the highest recorded since 1899. Almost the whole of this output is derived from the Eustis mine at Eustis and the McDonald mine at Weedon (see this BULLETIN, 1913, **11**, 365).

Among other minerals there were increases in the output of gold and silver, mica, phosphate, graphite (see p. 536), titaniferous ores, magnesite, granite, limestone, and sand. There were decreases in the output of iron ores and ochres, chromite, slates, cement materials, marble, and quartz.

The Report on mining operations for 1911 includes four special features, viz.: (1) a report on Montreal Quarries; (2) a preliminary report on some titaniferous iron ore deposits on the north shore of the river and gulf of St. Lawrence; (3) a report on the magnetic sands of the north shore of the gulf of St. Lawrence; (4) a report on the geology and mineral resources of the Keekeek and Kewagama Lakes region.

Dredging in the Sudan.—An interesting series of photographs illustrating the dredging plant employed by the Sudan Irrigation Service in dredging and confining the Upper Nile has been received at the Imperial Institute from the Secretary of the Central Economic Board, Khartoum. The plant has been designed by Mr. A. W. Robinson, M.I.C.E., of Montreal, to meet the special requirements of the region, and forms the first experimental unit of the Sudan dredging fleet. It consists of a six cubic yard grab dredge, manufactured by Messrs. Simon and Company, of Renfrew; a seven cubic yard dipper dredge, by the Atlantic Equipment Company, of New York; a 24-in. hydraulic dredge, by Messrs. Lobnitz and Company, of Renfrew; one tow-boat, by Messrs. James Rees and Sons, of Pittsburg, for coal transport; and six

coal barges. The first two dredges are used for the removal of sudd and similar material; and the other for mud and silt. The fleet is the property of the Egyptian Government and was erected in Khartoum by the Sudan Government Steamers Department.

Since the commencement of dredging operations in 1909 much useful work has been accomplished in deepening the Bahr-el-Zeraf to allow free navigation throughout the year; in excavating a channel which gives that river perennial communication with the Bahr-el-Gebel; and in modelling and re-banking both these rivers.

Photographs of this equipment which were taken by Mr. Robinson are now exhibited in the Sudan Court of the Exhibition Galleries of the Imperial Institute, and comprise the following views:

Dipper Dredge.—1. "View showing the dredge excavating a new channel through the papyrus swamp and depositing the spoil in a continuous bank. The average output is about 200 cubic yards per dredging hour."

2. "View showing the loaded bucket, dipper arm and end of boom, ready for swinging and dumping the spoil."

3. "View showing a very full bucket in position for pulling the trigger and dumping the spoil."

4. "View showing a new channel, 25 yards wide and 12 ft. deep, excavated through the swamp from the Bahr-el-Gebel to the Bahr-el-Zeraf—the spoil being deposited so as to form two continuous banks."

Hydraulic Dredge.—5. "Front view showing the dredge, floating pipe, and terminal pontoon in working position."

6. "Rear view showing the dredge excavating from the bed of Bahr-el-Zeraf and depositing the spoil on the banks."

7. "View of the specially designed pontoon, showing how the spoil is passed to the suspended discharge pipe through the floating pipe."

8. "View showing the end of the suspended discharge pipe, with spoil emerging. The output of solid material when working in soft mud has reached 1,000 cubic yards per dredging hour."

Grab Dredge.—9. "View showing the dredge widening the channel of the Bahr-el-Gebel by excavating the papyrus with a specially designed bucket."

10. "View showing the specially designed bucket excavating papyrus and vegetation."

11. "View showing the bucket open, as dropped on to the papyrus, and ready for closing and lifting."

Tow-boat.—12. "View showing the tow-boat 'Egypt' transporting a load of 2,000 tons of coal and other cargo from Khartoum to the swamp region for the dredging fleet."

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

Soils.—The nitrogenous constituents of soils and their bearing on soil fertility is the subject of *Bulletin* No. 87, 1912, *Bur. Soils, U.S. Dept. Agric.* Previous investigations have shown that numerous nitrogenous organic compounds occur in soils, and the work now recorded concerns their effect on wheat seedlings. It is shown that nucleic acid, hypoxanthine, xanthine, guanine, creatinine, histidine, arginine, and choline are beneficial to plant growth and that the addition of any one of these substances to culture solutions containing only phosphoric acid and potash, greatly increases growth. It is suggested that these compounds are used directly in building up proteins, as no evidence of the formation of ammonia, nitrates, or nitrites was found; they also appear to be able to replace nitrate as a nitrogenous plant food.

Certain nitrogenous compounds were found to have a harmful effect on plant growth. Amongst these guanidine is of interest as it produces effects similar to those caused by certain plant diseases, such as bleached spots on the leaves, which finally spread and give rise to wilting. These effects are accentuated by the presence of nitrates. In an appendix a useful table is given showing the recorded effects of numerous organic compounds on plants and their mode of occurrence in nature.

The changes which occur in certain of the organic constituents when soils are steam-heated are discussed in *Bulletin* No. 89, 1912, *Bur. Soils, U.S. Dept. Agric.* A number of samples of two types of loam were heated for three hours by steam at 30 lb. pressure at a temperature of 135° C. They were then treated with a 2 per cent. solution of caustic potash for seven hours, and the solution thus obtained was examined by methods detailed in the paper. The general effect of the heating was to increase the acidity of the soil and the proportion of soluble constituents. It also caused the formation of certain decomposition products of nucleic acid and protein material, such as xanthine, hypoxanthine, guanine, cytosine, and arginine, which are beneficial to plant growth (*see above*). In some of the samples, the harmful dihydroxystearic acid was present after heating, although it could not be detected before this treatment. It is thus evident that steam-heating produces

compounds both beneficial and harmful to plant growth, and the good effects of heating can only be seen when the harmful products have been reduced in quantity or eliminated. In the case of dihydroxystearic acid this result can be attained in several ways, such as by adding lime nitrates, etc., to the soil. Cultural experiments showed that a heated soil gave a poorer crop than one untreated, unless some such method of treatment was adopted. An interesting point in connection with this investigation was the recognition, for the first time, of guanine as a soil constituent.

The nature of the carbonaceous material found in soils is dealt with in *Bulletin* No. 90, 1912, *Bur. Soils, U.S. Dept. Agric.* The carbonaceous matter was separated from large samples of a number of soils and was found to consist of one or more of the following products: coal, lignite, charcoal, or plant and insect remains. The charcoal-like particles are probably not due entirely to the action of fires, as they were found in some cases at depths of 15 to 50 ft. The influence of these various forms of carbonaceous matter on the accuracy of the methods usually employed for the determination of organic matter in soils is also discussed.

An account of the soils occurring in the neighbourhood of Kopjes, Orange Free State, is given in *Agric. Journ. Union of S. Africa* (1913, **5**, 545). The object of the investigation was to ascertain the nature and extent of the alkali salts ("brack") present in the soil in the neighbourhood of the proposed irrigation works, so as to form some idea of the effect that irrigation will have on the fertility of the soil. Nine boreholes were sunk and samples of soil, taken at depths of 1, 2, 3, and 4 ft., were chemically examined. The salts present in largest quantity were found to be sodium sulphate and chloride, whilst the more dangerous sodium carbonate was absent in many cases. The results of the investigation indicate that it will be necessary to drain part of the area examined in order to avoid an increase in the quantity of salts present in the top soil and the consequent loss of fertility. Most of the soils contain satisfactory quantities of nitrogen, lime, and potash, but are deficient in phosphoric acid. The physical condition of many of the soils is stated to be far from satisfactory, many of them caking badly on drying.

Manures.—By a resolution of the German Imperial Parliament, adopted in 1911, part of the funds voted for the furtherance of the German potash industry are to be devoted to manurial experiments in German Colonies. A preliminary report on the experiments carried out in German East Africa during 1911–12 is given in *Düngungversuche in den Deutschen Kolonien* (German Imperial Colonial Office, Berlin, 1913). It is pointed out that the soils

as a whole are not very rich in plant food and cannot be cultivated profitably for a long period without the addition of manure. The results of experiments on rubber, coffee, cocoa, coconuts, Sisal hemp, cotton, maize, cereals, and vegetables are recorded, but owing to the short period which the records cover, the results are not regarded as conclusive.

Foodstuffs

Wheat.—The *Agric. Journ. Union of South Africa* (1913, **5**, 565) contains an account of variety trials with wheat grown as a winter crop under irrigation. Of the varieties tried "Egyptian Red" gave the best yields, its average for six years being 1864 lb. per acre. Although more rust-resistant than most varieties, this wheat yields grain of very poor quality. The third wheat in point of yield, an early, beardless, white, Australian kind, produced the best flour. This wheat, as well as "Glujas Early" and "Potchefstroom White," are recommended for the production of meal for household purposes in South Africa.

It was found that wheat grown on land which had borne legumes in the previous season produced a larger yield than when it followed maize, tobacco, sunflowers, or linseed.

Further details regarding "Marquis" and "Prelude" wheats are contained in the *Rep. Exper. Farms, Ottawa*, 1911–1912, p. 117. The previous records for "Marquis" were surpassed last season at Rosthern, where 70 bushels per acre were harvested. During trials extending over four years at Brandon, "Marquis" yielded 10 per cent. more crop than "Red Fife," and at Indian Head, 50 per cent. more. "Early Red Fife" resembles "Marquis" in many respects, and has an equally good record, but is more subject to rust. "Prelude," a very early variety, at Indian Head last year required 113 days to mature, as compared with 131 days in the case of "Marquis," and 138 days in the case of "Red Fife." "Prelude" was cut on August 10, and yielded 38 bushels per acre. During the two years in which it has been grown at Ottawa, it has ripened in 92 and 82 days respectively, and yielded on an average 31¼ bushels per acre.

Oils and Oil Seeds

Coconuts.—The exports of coconut products from Ceylon in 1912 were smaller than in 1911 and 1910 (*Trop. Agriculturist*, 1913, **40**, 186). This may be accounted for partly by increased local consumption and partly by reduced crop as a result of drought, but the many young plantations coming into bearing should compensate for this. It is considered that the smaller exports are also in part due to the unpro-

ductiveness of the older plantations, and the necessity for improved cultivation is strongly urged. In connection with this question it is interesting to note that exhaustive experiments on the cultivation and manuring of coconuts have been commenced at Peradeniya (*Bulletin* No. 2, *Ceylon Dept. Agric.* 1912). Among the questions which are being investigated are (1) whether old trees (about fifty years) respond to cultivation and manuring; (2) the best form of cultivation; (3) the effect of different manures; (4) the effect of green manures and mulching. Records of the cost of cultivation and manuring and of the value of the crops produced, etc., are also being kept.

The area under coconuts in British Guiana is increasing (*Rept. Dept. Sci. and Agric. Brit. Guiana*, 1911–12, p. 7), there being 12,236 acres under this crop at the end of 1911. The spacing of the trees is good on some of the newer plantations. Diseases are prevalent on the neglected plantations and many trees die from want of drainage. Legislation will be necessary unless planters pay more attention to cultivation and the control of pests and diseases. Trees grown from Tobago nuts are not so promising as those from local nuts, which are presumably better suited to the local soil and climate.

About 200 acres of land are under coconuts in Antigua, but the plantations are comparatively recent and only sufficiently advanced to show that the cultivation is likely to be fairly successful (*Rept. Bot. Stations and Expt. Plots Antigua*, 1911–12, p. 27). Further areas are to be planted, and a trial is also to be made in Barbuda.

Ground Nuts.—The output of ground nuts in the Kano district of Northern Nigeria has increased considerably. According to Lamb (*Nigerian Customs and Trade Journ.* 1913, **3**, 317), the sandy plains of Bida and Kano form an ideal soil for the cultivation of ground nuts, and yields of over 1 ton per acre of freshly harvested nuts have been obtained. This corresponds to at least 1,400 lb. of dried kernels, which sell at Kano for $\frac{5}{8}$*d.* per lb., thus realising about £3 13*s.* per acre. This is considered a good return by the producers, and an increased output is anticipated in the present season. If prices were somewhat higher and facilities for marketing the nuts better, larger quantities would be produced in the Nupe district. The establishment of depots for buying the nuts is suggested, while it is stated that the erection of machinery for decorticating nuts would be advantageous in certain districts and should also prove remunerative. The trading firms refuse to buy the unshelled nuts, and the labour of shelling by hand is very considerable; one woman can only deal with about 7 lb. of unshelled nuts per hour, i.e., assuming that the nuts consist of 66 per cent. of dry

kernels and 34 per cent. of shells, 320 hours would be required to shell 1 ton of nuts.

The unshelled nuts can be obtained from the natives at a much lower price than the kernels, and, in spite of the greater cost of transport, it is considered that the export of unshelled nuts is worth consideration. A superior variety producing large nuts is grown near Pategi; a sample of this variety was examined recently at the Imperial Institute and was valued at £19 per ton.

Linseed.—Since the successful experiments carried out at the Kakamega Roman Catholic Mission, British East Africa, linseed cultivation has been taken up rapidly by the natives and promises to become thoroughly established throughout a large part of the Nyanza Province (*Rept. Dept. Agric. Brit. East Africa*, 1911–12, p. 100).

Oil Palm.—Although the quantities of palm oil exported from the ports of Lagos and Opobo are approximately equal, Opobo has for many years past exported very much smaller quantities of palm kernels than Lagos; thus, in 1911 17,552 tons of palm oil and 82,292 tons of kernels were exported from Lagos, while 17,604 tons of palm oil and only 18,645 tons of kernels were exported from Opobo (*Lagos Customs and Trade Journ.* 1913, **3**, 105). It is difficult to ascertain the reasons for such a remarkable difference, but it appears to be due to a variety of causes, among which may be mentioned the smaller home consumption of oil by natives in the Eastern Province, and also the fact that there are very few trading stations in the Opobo district, and consequently less inducement for the natives to produce commodities to exchange for cloth, etc., while the inclusion in the Lagos exports of quantities of kernels brought down from Ibadan and other stations by railway is also a factor. It is considered, however, that much greater quantities of kernels might be produced in those districts of the Eastern Province lying between the Niger and Cross rivers, and that a railway would do much to encourage this. Attempts are being made to introduce better methods of cracking palm nuts.

According to Bret (*Journ. d'Agric. Trop.*, 1913, **13**, 139), it is difficult to obtain regular supplies of palm fruits from existing oil palm areas in quantities sufficient to satisfy the needs of modern installations requiring such large quantities as 50 tons of palm fruits per day, on account of the fact that many of the trees are old and unproductive, and because their height renders the harvesting of the fruits difficult. The author considers that large installations will find it necessary to clear the areas considerably, and eventually to make use of the younger trees as they become available. Such methods of clearing have been

adopted near Bingerville, Ivory Coast, while young palm trees are being planted out at distances of about 30 ft. by 17 ft., and interplanted with cocoa. Young palms can be planted out up to the age of three or four years if this is done at the beginning of the wet season.

Large tracts of land covered with oil palms exist in Portuguese Guinea (*Board of Tr. Journ.*, 1913, **81**, 428), but are mostly unexplored or imperfectly explored at present Land can be granted on feu ("aforamento") by public auction in areas up to 25,000 hectares (61,750 acres), but applicants must be naturalised Portuguese citizens or have resided in Portuguese territory for over six months.

Sesamum Seed.—In experiments in the East Africa Protectorate a crop of 350 lb. per acre was obtained at a cost of Rs. 9·5. When the seed is sown in May heavier crops are obtained than when sown, according to native practice, in October (*Rept. Dept. Agric. Brit. East Africa*, 1911–12, p. 101). The industry has assumed large proportions and continues to extend among native cultivators. Sesamum is recommended as a catch crop on large plantations.

Soy Beans.—Further trials have been made during 1912 with soy beans in Egypt (*Agric. Journ. of Egypt*, 1913, **2**, 91). The seeds were sown on heavy black loam land on May 13, the land being watered a few days previous to sowing. The young plants were watered three weeks after sowing the seed, but did not receive water again until fifty-five days later. The crop showed no signs of suffering from lack of water. A part of the crop was cut on August 1 and used for fodder, the yield being nearly 6 tons per acre. It was found that cattle, sheep, and goats ate the fodder, but that donkeys and mules would not do so. The remainder of the crop was harvested on August 31, the following yields of dry seed in lb. per acre being obtained from the different varieties: Manchurian, 1,257; Medium Yellow, 1,596; Eltum, 1,061; Morse, 1,486. These results are better than those obtained in 1911, and may be due to the fact that the seed was sown six weeks earlier, or because the land had borne a crop of peas during the previous winter.

The cultivation of soy beans and the conditions of the industry in China are discussed in the *Bulletin de la Société Belge d'Études Coloniales* (1913 **20**, 367).

Miscellaneous.—Trees of *Calophyllum Inophyllum*, L., in German East Africa have fruited well, but there does not seem to be much demand for the seed in Germany (*Der Pflanzer*, 1912, **8**, 529).

The seeds of *Euphorbia gregaria*, Marloth, from German South West Africa, have been found to contain about 42 per cent. of oil (*Arbeit. Pharm. Inst. Berlin*, 1912, **9**, 227). No

information is given as to the possibility of obtaining commercial supplies of the seed.

Candle nut trees (*Aleurites triloba*) are plentiful in Hawaii (*Journ. Soc. Chem. Ind.* 1913, **32**, 496), there being some 15,000 acres covered with this tree, which, if the nuts were systematically harvested, should yield 2,375,000 gallons of oil annually.

Trees of *Rhus succedanea*, L., the seeds of which yield Japan wax, grown in German East Africa, produced seeds which would fetch fairly good prices in Germany (*Der Pflanzer*, 1912, **8**, 529).

Attempts have been made to grow candelilla plants at Amani, in German East Africa, but the climate appears to be too moist for them (*ibid.* p. 249).

Essential Oils

Oil of Artemisia vulgaris, L.—Messrs. Schimmel and Co. (*Schimmel's Report*, April 1913, p. 28) have examined a sample of oil distilled in Bengal from *A. vulgaris, L.*, which they received under the name of "Indian Wormwood Oil." The oil was yellow in colour, with a greenish fluorescence, and possessed a sage-like odour. It was found to have the following physical constants: Specific gravity at 15° C., 0·9219; optical rotation in 100 mm. tube, $-8° 52'$; refraction at 20°, n_D 1·46201. α-Thujone was identified in the oil, and borneol also is believed to be present (see also p. 436).

Borneo Camphor Oil.—A detailed examination of a sample of the oil of *Dryobalanops aromatica*, Gärtn. (Borneo camphor), from Singapore has been carried out by Messrs. Schimmel and Co. (*Report*, April 1913, p. 32). The oil had specific gravity at 15°, 0·918, optical rotation in 100 mm. tube, $+11° 5'$, and was found to consist of 35 per cent. of terpenes (*d*-α-pinene, β-pinene, camphene, and dipentene), 10 per cent. of alcohols (borneol and α-terpineol), 20 per cent. of sesquiterpenes, and 35 per cent. of resin.

Oil of "Wild" Cardamoms.—Messrs. Schimmel and Co. (*Report*, April 1913, p. 111) have distilled some "wild" cardamoms, originally derived from Indo-China, of which the parent plant was identified as *Amomum globosum*, Lour. A yield of 4 per cent. of oil of an odour recalling that of camphor oil was obtained. The constants of the oil are given, and are stated to be somewhat similar to those of the oil of "Ceylon cardamom seeds," although the two oils differ considerably in odour. A considerable proportion of camphor is believed to be present in the oil, but, owing to lack of material, this could not be definitely determined.

Rubber

Hevea brasiliensis.—In the *Agric. Bull. Fed. Malay States* (1913, **1**, 323) F. G. Spring gives some preliminary notes on tapping experiments at Kuala Lumpur. Six systems of tapping were tested:

(1) Quarter (half herring-bone), two cuts 18 in. apart, daily tapping. (2) Adjacent quarters (full herring-bone), two cuts 18 in. apart on each quarter, tapped on alternate days. (3) Single V, 36 in. from base of tree, tapped daily. (4) Double V, cuts 18 in. apart, tapped on alternate days. (5) Opposite quarters, one cut of 36 in. on each quarter. (6) Opposite quarters, two cuts 18 in. apart, tapped on alternate days.

In each plot tapping areas were so marked that the circumference of each tree is completely tapped in four years. The number of trees in each plot is sixty-five, and the distance of planting 16 ft. by 16 ft. A table of yields is given for the two years during which the experiments have been in progress. The results go to show that the V system of tapping gives the greatest yield of rubber, als that daily tapping gives a greater yield of rubber than tapping on alternate days for the same amount of bark removed.

The Spotting of Plantation Para Rubber is discussed by K. Bancroft in *Bulletin* No. 16, 1913, *Dept. Agric. Fed. Malay States*. According to the author neither smoked sheet-rubber nor crêpe artificially dried develops spots, but unsmoked sheet is liable to do so, and steamed crêpe is very susceptible to spotting. Spots appear during the process of drying, and may become visible at the end of a week or even earlier. The discoloration increases until the rubber is quite dry, when its development is arrested. In some cases the colour may fade, in others the colour remains even after eight or nine months. Microscopic examination of the residues of the spots after dissolving away the caoutchouc by means of benzene or xylene show structures resembling the hyphæ of fungi.

By transferring spotted rubber to cane juice agar the author isolated a fungus closely resembling in character *Monascus heterosporus*, Schröter. Its causal relation to the production of colour (pink) was established by inoculating fresh rubber with the fungus, and producing the pink colour; control samples of rubber not infected developed no coloration. Further, the author re-isolated the fungus with all its original characteristics from the artificially infected rubber. By the same method a new species of *Spondylocladium*—*S. maculans*—was isolated from a yellowish-red crêpe rubber.

In another experiment thin slices of a red-coloured rubber were transferred to cut surfaces of sterilised

potatoes. In about five or six days three of the surfaces showed a pink colour, and on examination a fungus was found of the form-genus, *Mycogone*.

From a dark blue spotting of crêpe rubber the author also isolated, by means of cane juice agar, a fungus indistinguishable from the "Diplodia" form of *Thyridaria tarda*, the fungus which causes the "die-back" disease of the stem of the Para rubber tree. Species of *Penicillium* and *Aspergillus* were also found.

A micro-organism having all the characteristics of *Bacillus prodigiosus* was isolated from some red discolorations by means of nutrient bouillon and agar-agar. In other samples of spotted rubber a species of *Sterigmatocystis* and a red yeast (unidentified) were also found.

All these organisms occur widely distributed. The Diplodia-form occurs in the Federated Malay States on any recently dead vegetable matter. The author isolated *Monascus heterosporus* and *Spondylocladium maculans* from poles of uncured jungle wood used for hanging rubber in the drying-houses. *Sterigmatocystis* and *Bacillus prodigiosus* are ubiquitous.

As preventive measures the author recommends acceleration of the drying process. The beneficial effect of smoking is attributed partly to the antiseptic properties of the smoke and partly to its hastening the drying of rubber. The use of chemicals is not recommended owing to their deleterious effect on rubber (cf. this BULLETIN, 1913, **11**, 348). Periodic fumigation of the drying-house with sulphur dioxide or spraying with formalin is recommended wherever possible. Spotted rubber should be isolated. The tables and racks of the drying-room should be kept scrupulously clean, and green wood should not be used in their construction. Latex which produces discoloured scrap should be treated with formalin before coagulation. According to the author the discoloration may sometimes be removed by rewashing and crêping the dry rubber.

Hevea Latex.—*The India Rubber Journal* (1913, **45**, 941) contains an article by G. S. Whitby entitled "Some preliminary observations regarding the causes of natural changes in the latex of *H. brasiliensis*." When Hevea latex issues from the tree it is faintly alkaline, but within a short time it becomes faintly acid. If the latex is allowed to stand the acidity increases, and within a few hours the liquid becomes converted into a solid mass. Later putrefaction occurs, and the surface becomes yellow and slimy. Hevea latex always gives the guaiacum and pyrogallol reactions for peroxidases, but in no case was the author able to detect the presence of oxygenase. Latices which darkened rapidly gave a much more marked peroxidase reaction than normal latex. Latex from the higher parts

of the trunk showed a much greater tendency to darken than latex from the lower part of the trunk. Specimens of latex drawn from a tree at points separated by only a vertical distance of 7 in. showed a distinct difference in the tendency to darken. The oxidase, however, is not responsible for the natural coagulation of latex, as this occurs as readily in the absence as in the presence of air. Natural coagulation also occurs too rapidly to be the result of bacterial action. The author also thinks that the natural coagulation is not merely the result of the acid which develops in the latex, because the two phenomena do not occur *pari passu*. For instance, the formation of acid takes place much more rapidly in diluted latex than in undiluted latex, and diluted latex may develop sufficient acid without coagulation taking place (see, however, this BULLETIN, 1913, **11**, 347). The author regards the coagulation of Hevea latex as essentially a physical change, conditioned in the case of natural coagulation by preliminary chemical change brought about by an enzyme, probably a protease. Heating to a temperature which destroys the enzyme prevents coagulation for a time. The darkening of latex is hastened by the addition of phenolic bodies, and the author concludes that the darkening of latex is due to changes produced in phenolic substances present therein (cf. this BULLETIN, 1913, **11**, 348).

Bacterial Disease of Hevea Brasiliensis.—In the *Agric. Bull. Fed. Malay States* (1913, **1**, 268) E. Bateson describes the discovery in the wood of a dead Hevea tree of bacteria which may have been the cause of the death of the tree. Attempts to infect seedlings with the bacterium failed, but the author thinks it advisable to warn planters of this possible bacterial disease of Hevea.

Euphorbia Tirucalli.—In the *Agric. Journ. of the Union of South Africa* (1913, **5**, 706) H. Noyes describes the collection of latex from *Euphorbia Tirucalli* in Natal. This tree is described as a "hard-timbered, rough-barked, leafless tree of umbrageous habit, attaining in good soil and under favourable conditions a height of 25 to 35 ft., and a diameter of 1 to 2 ft. In lieu of leaves it bears at the extremities of the branches bunches of thin leathery fingers, which when broken yield a watery latex." Its natural habitat is in the hot valleys of Natal, between latitudes 25° and 32° S. A well-grown tree, if properly worked, yields latex to the value of 2*s.* 6*d.* per annum. The tree grows vigorously in any soil, provided the altitude is not excessive. It reproduces itself freely, and can be grown from seedlings or stumps. It is best tapped on the half herring-bone system on one quarter of the circumference, in the same manner as Hevea trees. With healthy and well-grown trees tapping

may be carried out twice weekly. The latex is coagulated, after standing twenty-four hours or more, by means of a solution of tannin, or a mixture of tannin and hydrochloric acid, and the coagulum is dried until it contains 25 per cent. of moisture. The dry coagulum contains on the average 13·5 per cent. of caoutchouc, but, according to the author, there is a considerable and increasing demand for the crude coagulum.

Fibres

An account of the fibre industries of the East Africa Protectorate is given in the *Ann. Rep. Dept. Agric., British East Africa*, 1911–12. The prospects of the Sisal hemp industry are satisfactory, and a rapid extension of the area under cultivation in the highlands is anticipated. In the Gazi section, 800 acres have been planted, and of these 75 acres are ready for cutting. The leaves produced by the plants in this district vary from 3 ft. 6 in. to 5 ft. 6 in. in length, and although thinner than those grown in the highlands, they give a large yield of fibre which is of good strength and colour. Extracting machinery is being installed, and the area under the crop is being extended. The preparation of Sansevieria fibre from the indigenous plants is being continued in the neighbourhood of Voi, and the heavy rains which have been experienced are expected to stimulate the production of new leaves in the areas which have already been cut, and thus enable the output of fibre to be increased. Attention is being directed to the floss or silk-cotton, known as "Sufi," which is furnished by a large tree (probably *Bombax* sp.), common at several places along the coast-belt.

Flax.—An association, known as "The British Flax and Hemp Growers' Society," has been formed recently, and was referred to in *The Times* of June 17, 1913. The principal objects of this society are to make experiments on a commercial scale, to distribute information, and to collect and collate trustworthy particulars on the cultivation of flax and hemp, the retting of the stalks, and the preparation of the fibres in Great Britain. The experimental work outlined for the season of 1913 includes the cultivation of the flax plant for both seed and fibre, and the cultivation and extraction of hemp. The work in connection with the cultivation of the flax plant for the production of linseed has been delegated to the South-Eastern Agricultural College, Wye, and arrangements have been made for the establishment of two-acre plots in seven or eight districts in various parts of England and Wales, including localities in Surrey, Shropshire, Yorkshire, and Carnarvonshire. Trials are being made with different varieties of seed, and manurial experiments are being undertaken. An endeavour is being made to obtain a pure strain of the plant for

production of both seed and fibre. The society has arranged for the cultivation of 120 acres of flax at Selby, Yorkshire, and the Leeds University is being invited to conduct the experiments in retting the stalks and preparing the fibre. Selby was chosen as one of the first districts for the revival of the industry, as flax-growing was carried on there largely in the past. Flax is also being cultivated near Yeovil, where 40 to 50 acres have been planted. Retting experiments are to be carried out there by a committee of growers, local representatives of the society, and nominees of Bristol University. This attempt to revive the cultivation of flax and linseed in Great Britain is due to the desire of farmers to take advantage of the introduction of such crops into rotation systems, and to the hope that it may lead to increased employment of labour.

Reference has already been made in this BULLETIN (1903, **1**, 188; 1912, **10**, 498) to the experiments on flax cultivation which have been conducted by the Department of Agriculture and Technical Instruction for Ireland. The work has been continued, and an account of the experiments carried out during 1911 is presented in the *Journ. Dept. Agric. and Techn. Instr., Ireland* (1913, **13**, 515). The results of manurial trials have confirmed the earlier work, and in the light of experience so far obtained flax-growers are recommended to apply 5 cwt. of kainit or 1½ cwt. of muriate of potash per acre, either at the time of sowing or during the previous winter. Experiments carried out with different kinds of seed have led to the conclusion that the choice of the variety to be sown (whether Dutch or Riga) must be determined by the quality of the seed itself rather than by the class of soil for which it is intended. Farmers are therefore advised to consult the leaflet on flax-seed issued annually by the Department, which gives information as to the harvest conditions prevailing in the two seed-producing countries during the preceding year, and indicates the quality of the seed procurable from each. Trials on both a large and a small scale have been made with a view to ascertaining whether seed obtained from a crop in the comparatively green condition in which it is considered ready for harvesting for fibre is less suitable for sowing than that obtained from a crop which has been allowed to mature completely before being pulled. Very little difference could be detected between the results yielded by the two kinds of seed, and it is thus evident that the seed from flax, pulled at the usual time, is quite suitable for sowing.

Cotton

East Africa Protectorate.—It is stated in the *Ann. Rep. Dept. Agric., British East Africa*, 1911–12, that experiments which were made in Gosha on the Juba river during the

year under report gave encouraging results. The varieties tested were Abassi, Mitafifi, and Yannovitch, and of these the first appeared the most promising. An extension of cotton growing by Europeans has taken place on the banks of the Tana river, and in one or two other districts, but attempts to expand the native cotton industry have not generally met with very great success.

India.—In an article entitled "The Problem of the Improvement of the Indigenous Cottons of the United Provinces" (*Agric. Journ. India*, 1913, **8**, 47), an interesting account is given of efforts to improve the cotton of these regions by direct selection and by breeding. In the Aligarh district a type has been isolated which gives a ginning yield of nearly 40 per cent., as compared with 33 per cent. furnished by the ordinary "desi" cotton, and a yield per acre about 30 per cent. greater than that of the latter. The fibre is not much better than that of the "desi" kind, but the greater productiveness of the new type, and the greater profit obtainable from it, are expected to lead to an increase of the area planted. During 1912–13 1,500 acres were sown with this type, and it is anticipated that in 1913–14 it will be grown on about 20,000 acres. Another type which has been selected does not give the high ginning output of that just mentioned, but yields a lint of improved quality; it is expected that about 450 acres will be planted with this cotton in 1913–14. Two other types described are early maturing varieties, and one of them bears naked seed which enhances the value of the crop for the production of cotton-seed cake. An account is given of hybridisation experiments carried out with the object of obtaining a cotton combining good quality with a high ginning yield. Numerous forms have been isolated, and these are being tested on a seed-farm recently established near Aligarh.

The native cottons of Burma are of very inferior quality, and all attempts to grow better varieties have been frustrated owing to the damage inflicted by insect pests. The various insects have therefore been studied, and are described together with the measures best adapted to control their depredations in *Bulletin* No. 8 (1912), *Dept. Agric., Burma.*

West Indies.—An account of the progress of the cotton industry of St. Vincent is given in the *Rep. Agric. Dept., St. Vincent*, 1911–12. During the year under review the area planted was the greatest yet recorded, and amounted to 5,068 acres of Sea Island, and 1,037 acres of Marie Galante. The increase was due to more extensive planting by the peasantry. Owing to a very unfavourable season, however, the yield per acre amounted on the average to only 96 lb. of lint per acre, as compared with an average

of 150 lb. for the six preceding years. The average price obtained for the Sea Island cotton was 19*d.* per lb., as against 18*d.* per lb. in 1910–11, and that for the Marie Galante variety was 10*d.* per lb., as compared with 9*d.* in 1910–11. Work on the selection and disinfection of seed has been continued, and the results are recorded. The local Sea Island variety has become thoroughly acclimatised, and is much more resistant to disease than newly imported kinds.

The cotton industry of Antigua increased rapidly from 1903 to 1907, but declined greatly during 1908 and 1909. Since this time, however, a steady improvement has taken place, and it is stated in the *Rep. Bot. Station and Expt. Plots, Antigua*, 1911–12, that in a few years the industry will probably be on a much firmer basis than it ever was previously. The area under cultivation during 1911–12 amounted to 495 acres, and yielded 70,209 lb. of lint, equivalent to an output of 142 lb. per acre. In Barbuda 130 acres were planted, and furnished 14,280 lb. of lint, or about 110 lb. per acre, this small yield being due to the extremely dry weather which prevailed. Experimental work on the selection and hybridisation of cotton has been continued, and the greater part of the cotton now produced in Antigua is grown from seed selected by the Department of Agriculture. This probably accounts to some extent for the increased yields now obtained.

FORESTRY AND FOREST PRODUCTS

Indian Timbers.—The following Indian timbers are described in the order named in *Forest Bulletin* (1913, Nos. 16–21), a bulletin being devoted to each species: Gumhar (*Gmelina arborea*, Roxb.), bija sal or vengai (*Pterocarpus Marsupium*, Roxb.), sain or saj (*Terminalia tomentosa*, W. & A.), benteak or nana wood (*Lagerstrœmia lanceolata*, Wall.), sandan (*Ougeinia dalbergioides*, Benth.), and dhaura or bakli (*Anogeissus latifolia*, Wall.). Information as to the distribution and habitat of the trees is given, together with notes as to the properties and uses of the timbers and minor products, the reproduction and rate of growth of the species, the method of extraction, and, when available, statistics as to out-turn and cost.

A small longitudinal section of the timber mounted on cardboard accompanies the description of each species.

Bamboos in Burma.—The forest reserves in the Pegu Forest Division are situated on both sides of the upper portions of the Pegu river and Pazundaung creek, which meet near Syriam, and enter the Rangoon river there (*Indian Forester*, 1913, **39**, 176). These forests contain a great variety of bamboos, some species of which cover extensive areas. The most common are the kyathaung

(*Bambusa polymorpha*) and the tinwa (*Cephalostachyum pergracile*), which occur in deciduous forests on well-drained, loamy soils usually associated with teak (*Tectona grandis*) and pyinkado (*Xylia dolabriformis*).

An enormous number of bamboos is cut yearly in the Pegu Division, the natives being allowed to cut as many as they please provided they take out the required licences. The working season is chiefly during the rains from July to November, but is suspended according to rules during the fire season. The industry is chiefly in the hands of bamboo traders, who extract the bamboos from the forests, and raft them down to large villages and towns, where they are sold. The principal species exploited are the kyathaung and the tinwa. The cost of the licence to the trader is Rs.3-2-0 per thousand bamboos. The cutting is done by men who usually work in gangs of from five to ten, and during the cutting season live in camps (*sakans*) of bamboo huts (*tays*) built by the side of the river. Bamboo clumps with straight culms, growing on fairly level ground not far from the river, are selected for cutting. From these are cut straight, healthy, mature culms that average in length about 20 ft. when trimmed at both ends. The culms are cut at various heights above the ground, the cutting being performed by means of sharp knives (*dahs*). On an average a man can cut sixty kyathaung and 100 tinwa bamboos in a day. At about a foot from one end of the bamboo, generally the thicker end, two notches are cut side by side about an inch long and an inch apart to form the drag hole or "napah." The culms are fastened together in fives by means of a slender strip of bamboo, which is passed through the "napahs" of the five culms. They are then made up into bundles comprising twenty kyathaung or twenty-five tinwa bamboos, fastened at one end only by means of thin strips of bamboo or cane. Two such bundles are lashed together, and are hauled down to the water by a pair of buffaloes harnessed to a rough yoke of wood. Sixteen bundles are placed side by side in the water, and are fastened together by means of three strong poles placed cross-wise on the upper side of the bundles. On the top of the poles fourteen similar bundles are placed, and securely lashed together. These thirty bundles, containing from 600 to 750 bamboos, form one section of a bamboo raft, which may comprise from five to ten such sections joined end to end. Generally about four men accompany a raft of 6,000 bamboos. Where the water is shallow the raft is propelled by poling, but where there is a sufficiently strong current it is allowed to drift down stream, being guided by means of long bamboo oars. Lighter rafts have to be constructed during the dry season, when the water is shallow; these consist of two to three layers of single bamboos, fastened together

as above described. By the time the bamboos are landed at Pegu the cost to the trader amounts to Rs.54 per 1,000 kyathaung, and Rs.38 per 1,000 tinwa bamboos. The selling prices at Pegu for these species are Rs.60 and Rs.43 per 1,000 respectively. Landed at Rangoon, the cost for bamboos brought down either the Pegu river or Pazundaung creek would be about Rs.60 and Rs.45 per 1,000 for kyathaung and tinwa respectively.

It is suggested that, owing to the quantity of material available for the manufacture of bamboo pulp, a mill situated at Syriam would prove a commercial success, and the clearing of the bamboo which would be effected thereby would prove beneficial to the more remunerative crops of teak and pyinkado, which are at present choked owing to the dense growth of bamboo.

ECONOMIC MINERALS

Graphite.—A description of the graphite mines of the Province of Quebec is given in the *Report on Mining Operations in the Province of Quebec for the year* 1910. The graphite is mined in the Buckingham district, where it occurs in the flaky or crystalline condition disseminated in gneisses.

At the Buckingham Graphite Co.'s mine the graphite is disseminated through a sillimanite gneiss, in a belt or zone the width of which varies considerably and reaches 10 ft. in places. The strike is south, and the dip 60° to the east. At the workings in the immediate vicinity of the mill, a tunnel has been driven in the side of a low hill from a distance of 300 ft., and two shafts have been sunk from the surface to the tunnel. The milling plant has a daily capacity of 60 tons of ore, yielding between 3 and 4 tons of finished products. The process of concentration is dry throughout. The ore is dried in a stone kiln by means of wood fuel. It is then passed through a Blake crusher, screens, and a second crusher, after which it is concentrated by passing through a series of rolls, screens, and bolts. The flake graphite then undergoes polishing in buhrstone mills. Three qualities of graphite are produced, of which the best contains 96 per cent. of pure graphite.

At the Bell Graphite Co.'s mine the graphitic gneiss occurs in two bands. One of these has been opened up; it strikes south 7° west, has a dip of about 70°, and has been traced for a distance of 2,000 ft. It varies in width up to 15 ft., has a foot wall of quartz rock, and a hanging wall of rusty gneiss. A drift has been driven into it a distance of 185 ft., and at 150 ft. a shaft has been sunk from the surface, 68 ft. above the drift. About 3,000 tons of ore, carrying an average of 8 per cent. of graphite, has been mined from the tunnel.

A considerable amount of development has taken place

at other mines, and now that the concentration difficulties have been overcome, the mining of these disseminated occurrences is a source of profit, and the graphite industry appears to be on a satisfactory basis.

According to the same *Report* for 1911, the shipments of graphite during that year were 753,405 lb., valued at $33,613, which is more than double the output in 1910, and the highest recorded up to that date. The graphite marketed during 1911 was sold at an average price of 4·46 cents per lb. By way of comparison it is stated that the best quality of flake graphite in large quantities was quoted at 10 cents per lb., whereas graphite dust sold as low as 1¼ cents per lb.

Magnesite.—According to the *Report on Mining Operations in the Province of Quebec during the year* 1911, a deposit of magnesite was discovered some years ago on lot 18, range xi, of Grenville Township, Argenteuil county. The locality is situated about 12 miles from the Canadian Pacific Railway, the nearest station being Calumet. The mineral at the surface contained from 10 to 19 per cent. of calcium carbonate, but quarrying has proved that below the surface the mineral is of better quality. The property was actively developed during 1911, and 100,000 tons of merchantable magnesite was blocked out. A grinding plant has been installed on the property; also a calcining kiln, with a capacity of 12 to 15 tons of the finished product per 24 hours. There is said to be an active demand for the product.

Steatite.—In a *Note on Steatite Deposits, Idar State* (*Records Geol. Surv. India*, 1912, **42**, 52), C. S. Middlemiss describes occurrences of steatite discovered during the field-season 1911–12. A large deposit occurs in the hilly area between the Bhil villages of Dev Mori and Kundol. The outcrop is situated in lat. 23° 39′ to lat. 23° 40′, long. 73° 28′. The bed runs N. and S. along the course of two streams, one of which flows N. and the other S., and traverses the intervening col. On either side are parallel ridges of quartzite. At one place the length of the outcrop can be traced for over a mile, showing a width of over 200 ft. and a practically vertical dip. The steatite appears to be fairly uniform in composition. It is finely schistose and of a greyish colour. It is of moderate quality, but not suitable for the finer trade requirements. Assuming a length of a mile, a width of 200 ft., and a depth of 20 ft., there appears to be over two million tons within easy reach of surface quarrying operations.

Tin Ore.—In *The Geology and Mining Industry of the Kinta District, Perak, Federated Malay States*, 1913, J. B. Scrivenor has given an account of the tin-ore deposits of the Kinta district, which lies in the upper part of the Kinta river valley. A large part of the district is occupied by granite,

which forms hills on either side of the valley. One side of the valley is flanked by limestone hills, and limestone forms also the floor of the valley. Lying on the limestone of the valley floor, and younger than the limestone, are clays, shales, and quartzites of Gondwana age; and some of these Gondwana clays are genuine boulder clays of glacial origin. Above these Gondwana strata there are some deposits of recent age, including alluvial beds and beds of lignite.

Along both sides of the valley the junction of the limestone and overlying Gondwana rocks with the granite is a fault junction, and the limestone hills which flank one side of the valley are mostly, if not wholly, fault blocks against which the younger Gondwana beds have been faulted. These structural features are of post-Gondwana age. They originated during the intrusion of the granite, which probably took place during Mesozoic times. During this intrusion, the Gondwana and other sediments were laterally compressed, and bent into a low anticlinal arch. This arch ultimately collapsed, and the strata broke up into blocks which subsided with a differential movement as large masses of strata fell into the granite magma. During the closing phase of the intrusive action, and as the granite mass was solidifying, stanniferous vapours were given off, and from these, tinstone and other minerals were deposited in the rocks. All this took place at considerable depth; but the superincumbent rocks have since been removed by denudation, which has brought out the structural features and laid bare the stanniferous rocks.

Tin ore occurs in all the formations of the Kinta district. In the granites, limestones, and Gondwana beds the ore occurs as primary veins, pipes, and impregnations, which owe their formation to pneumatolysis, *i.e.* to direct deposition from the vapours given off from the Mesozoic granite during the later phases of intrusive activity.

A large amount of the tin ore is, however, detrital, and represents the more stable of the rock constituents, including tinstone, which have resisted the agents of weathering and denudation, and have been distributed over the surface of the district. Such are the recent deposits, in which is found alluvial tin ore that has been derived from the various formations in which primary tin ore occurs. The ore also occurs in caves and solution pipes in the limestone.

One of the most interesting of the occurrences of tin ore is that where it occurs as a detrital constituent of the Gondwana clays and boulder clays, in which the hydraulic mines of the Gopeng, the Kinta tin, and the new Gopeng companies are worked. These Gondwana rocks carry primary tin ore which has been deposited in them directly by the agency of the Mesozoic granite, but the clays and boulder clays also contain large boulders of alluvial origin.

These latter clearly cannot have been derived from the Mesozoic granite, and the Government Geologist is of opinion that the tin ore has been derived from some mass of granite of Palæozoic age, the site of which is not yet known.

The primary pipes of tin ore that traverse the limestone, as at Ayer, Dangsang, and Lahat, have a gangue which is chiefly calcite; the other minerals occurring in the pipes are quartz, pyrite, chalcopyrite, bornite, arsenopyrite, and antimonite. Arsenopyrite is abundant, fluorite and tremolite are common, but tourmaline is rare in the limestone deposits. In the case of the Lahat pipe, the ore-contents of the pipe have been largely oxidised, and the calcitic matrix extensively dissolved by percolating water.

Other minerals which occur associated with cassiterite in the tin ores of the Kinta district are corundum, galena, cerussite, native copper, scheelite, wolframite, strüverite, monazite, xenotime, topaz, and siderite.

Titaniferous Iron Ores.—It is a well-known fact that there are in many parts of the world large deposits of iron ore which, owing to the high percentage of titanium they contain, are of little value in competition with ordinary non-titaniferous iron ore. The smelting of titaniferous ores is accompanied by much difficulty and expense with existing types of furnaces, and as a rule such ores are not saleable if they contain an appreciable percentage of titanium. According to the *Second Annual Report of the Director of the United States Bureau of Mines for the year ended June* 30, 1912, an investigation is being carried out on a small scale to test the possibility of utilising such titaniferous ores. Two deposits that have been examined, viz. at Sanford Hill in the Adirondack Mountains, N.Y., and at Iron Mountain, Wyo., are very large, and have not been utilised on account of their high percentage of titanium. The nature of the ores in these deposits has been studied, and they appear to consist of titaniferous magnetite in which, as is usually the case with this mineral, magnetite is intimately intergrown with ilmenite. Attempts have been made to reduce the amount of titanium by magnetic separation, and it was found that part of the ilmenite can be eliminated in this way; but it was found to be difficult, where not impossible, to obtain concentrates containing less than 6 per cent. of titanium.

It is inferred, therefore, that the utilisation of such iron ores is not feasible unless furnace practice can be so modified as to make practicable the smelting of concentrates that carry from 6 to 7 per cent. of titanium; or unless such concentrates are mixed with three or four parts of non-titaniferous ores, an alternative which is rendered practicable by the small amount of phosphorus and sulphur present in the concentrates.

F. L. Hess, writing on titanium in *Mineral Resources of*

the United States, 1911, *Part I., Metals*, states that most of the ferrotitanium now manufactured seems to be obtained from titaniferous magnetite or from ilmenite. Better results can be obtained in making ferrotitanium with rutile than with ilmenite, as the relative percentages of iron and titanium are more readily controlled, but the cheapness of ilmenite and titaniferous magnetite gives them a great market advantage over rutile. For making titanium carbide, however, ilmenite cannot be used, and there appears to be some demand for rutile for the manufacture of this substance, which is used in the form of electrodes for arc lamps. There appears to have been no rutile mined in the United States during 1911. A little was supplied for export from the Roseland mines in Virginia, but this was taken from accumulated stock. For an account of the distribution and uses of titanium ores see this BULLETIN (1911, **9**, 134).

NOTICES OF RECENT LITERATURE

THE NATION AND THE EMPIRE: Being a Collection of Speeches and Addresses: with an Introduction by Lord Milner, G.C.B. Pp. xlviii + 515, Med. 8vo. (London: Constable & Co., 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 11*d.*, abroad 11*s.* 4*d.*

The speeches of Lord Milner have a distinctive literary value and character not commonly found in the printed speeches of orators. But, as he says of himself, he is no orator: he is a man of action, an administrator, possessed with the Imperial idea and inspired by it. In a fine passage he reveals himself, thus: "If it is sometimes wearisome and distasteful to have to talk about the Empire, there is nothing so bracing, so inspiriting, as to try to live for it" (p. 330). His attitude towards Imperial Unity is clearly marked. "My ideal," he says (p. 163), "is to see the greatest number of people living healthy and independent lives by means of productive work in our own country. . . . I am not an individualist, and I am not a cosmopolitan. The conception which haunts me is the conception of the people of these islands as a great family, bound by indissoluble ties to kindred families in other parts of the world, and, within its own borders, striving after all that makes for productive power, for social harmony, and, as a result of these, and as the necessary complement and shield of these, for its strength as a nation among the nations of the earth." His view of the British Empire and its future is thus outlined: "When we, who call ourselves Imperialists, talk of the British Empire, we think of a group of states, independent of one another in their local affairs, but bound together for the defence of their common interests, and the development of a common civilisation, and so bound,

not in an alliance—for alliances can be made and unmade, and are never more than nominally lasting—but in a permanent organic union. Of such a union, we fully admit, the dominions of our sovereign, as they exist to-day, are only the raw material. Our ideal is still distant, but we are firmly convinced that it is not visionary nor unattainable" (pp. 90–91). Indeed, he is in favour of constructive statesmanship and the recognition of co-partnership interests in the consolidation of the British Empire and its Dependencies. His speeches are of special interest in connection with the problems of South Africa. In a significant passage, he says: "But though they [*i.e.* the self-governing Dominions] took part in the war, their participation in South African affairs ended with its conclusion. It was regarded as a matter of course that the United Kingdom alone should deal with the situation in South Africa as the war left it. In my opinion [*i.e.* in 1908], the policy to be adopted after the war should have been, like the war itself, the business of the whole Empire, and not of the United Kingdom only. If Canada, Australia, New Zealand had had a voice in it, if the organisation of the Empire had been sufficiently advanced to make that course practicable, I think we should see a more satisfactory state of affairs in South Africa than we do to-day" (pp. 311, 312).

The volume is dedicated to Mr. Charles W. Boyd, who selected, arranged, and annotated the speeches contained in it. The task has been admirably fulfilled. Arranged in the order of delivery—dating from March 1897 to December 1912—and covering the broad material issues or Imperial developments now so freely discussed in the Houses of Parliament and in the Press, the speeches and addresses, of necessity, contain occasional recapitulations—expansion of arguments rather than repetition of common phrasing—but throughout these there runs a singleness of purpose that gives unity to the volume as a whole.

One of the most far-reaching and important acts of Lord Milner has not generally received the recognition it deserves. The establishment of an efficient Department of Agriculture for the Transvaal, modelled on the lines of the Department of the United States, involved a heavy expenditure and was at the time the subject of much adverse criticism. The Department has proved to be of the highest value, and now forms the nucleus of the Agricultural Department of the Union.

PROCEEDINGS OF THE OPTICAL CONVENTION. Vol. II. Pp. viii+359, 4to. (London: University of London Press, 1912.) Price 10*s.*; post free, United Kingdom 10*s.* 5*d.*, abroad 11*s.*

This volume contains the proceedings of the second Optical Convention, held at South Kensington in June

1912. In his presidential address Professor S. P. Thompson gives a short history of the development of optics, and concludes with a strong plea for the provision of adequate educational facilities in this country for those who wish to study optics for its own sake. He deprecates the present practice of treating optics merely as a part of physics. He calls attention to the fact that though there are professors of electrical engineering and metallurgy in British Universities, there is no professor of optics. At the same time he is not anxious to put the larger study of optics under University control. He emphasises the need for the establishment of an Optical Institute, where the study of theoretical and practical optics will go hand in hand, and where the mathematician will grind his own lenses. Professor Thompson claims that the work of such an institute should be free from what he calls "the examination blight," and "the baneful influence of a University."

The thirty-six papers by eminent specialists that make up the volume deal with varied subjects, and cover a large part of the field of modern optics. The book is well printed and illustrated, and is a valuable addition to optical literature.

Poisons de Flèches et Poisons d'Épreuve. By Ém. Perrot and Ém. Vogt. Pp. xii+368, Royal 8vo. (Paris: Vigot Frères, 1913.) Price 15 francs; post free, United Kingdom 12*s.* 5*d.*, abroad 12*s.* 9*d.*

Prof. Gley, in a preface to this book, points out that the possibility of investigating arrow- and ordeal-poisons is rapidly disappearing, since the use of these materials by natives is diminishing as a natural result of the spread of civilisation. It is therefore particularly useful that this volume should be published now, not only because it gives a complete account of our present knowledge of these recondite subjects, but because it calls attention to numerous points on which information is incomplete. It may be hoped that one result of this will be that interest may be aroused in these subjects and new collectors and observers secured in those countries in which natives still make use of poisoned arrows and in which trial by the ordeal of poison has not been entirely suppressed. It is scarcely likely that such researches will at the present day afford results of practical value, but it must not be forgotten that several drugs now in use in European medicine owe their introduction into civilised medical practice to the investigation by chemists and physiologists of arrow- or ordeal-poisons used by natives. Among these may be mentioned strophanthus, curare, and Calabar bean.

Prof. Perrot and Dr. Vogt have ransacked ancient and modern literature for references to, and descriptions of,

poisons of these types, their method of preparation, and their composition and properties; and the information thus obtained is critically reviewed and stated in such a way as to make a peculiarly interesting book. The poisons dealt with are of varied types, including extracts of poisonous plants, snake venom, products of putrefaction, and preparations which are virtually primitive attempts at cultures of the tetanus and other disease-producing bacilli. It is curious to note that, no matter whether primitive man of early Europe or primitive man in Africa or Asia of the present day is considered, he seems always to have used for his arrows the most potently toxic material available. In the deserts, where vegetation of any kind is rare, the materials used were the irritant latices of Euphorbias and similar xerophilous plants.

The book is arranged geographically, and the poisons in use or formerly used in the various countries of Europe, Africa, Asia, Oceania, and America are considered in turn. Under "Nigeria," for example, there is a résumé of the papers published by Fröhlich, Mines, La Chard, Parson, Charteris, Laidlaw, and Bolton on the arrow- and spear-poisons used by the Munchis, Ceros, Binis, and other Nigerian peoples, followed by a similar chapter summarising what is known regarding the use of Calabar bean as an ordeal poison in that region.

The amount of literary research involved in the production of this work is enormous, but in spite of the authors' evident care to note everything of value, the book is not as complete as is desirable on the chemical side. Thus there is no reference to Salway's recent work on the chemistry of the Calabar bean, which certainly should not be overlooked by any one interested in this subject. Similarly, the account of the Asiatic aconites does not include all the most recent work on this subject. Further, the summary of the chemical work on the alkaloids of these plants is inaccurate in at least one point, and is, moreover, incomplete.

At the end of the section relating to each continent a map is printed showing the kinds of poisons used in each of the principal areas. There are also a number of illustrations of poisoned weapons and seven excellent plates showing types of arrows used in various parts of Africa (3 plates), Asia and Oceania (2 plates), America (2 plates), and an eighth reproduced from a photograph of a museum group of Perak natives preparing arrow poison. There are three indexes—(1) of native and scientific names of plants and animals used in preparing poisons, (2) of authors whose works are quoted in the text, and (3) of names of native peoples mentioned in the book.

There can be no question that the authors have rendered a signal service to science in compiling this book,

and they may rest assured it will long remain a most valuable source of information on a subject concerning which it has hitherto been extremely difficult to obtain accurate information.

An Introduction to the Chemistry of Plant Products. By P. Haas and T. G. Hill. Pp. xii + 401, Med. 8vo. (London: Longmans, Green & Co., 1913.) Price 7*s.* 6*d.*; post free, United Kingdom 7*s.* 11*d.*, abroad 8*s.* 3*d.*

The authors explain in the preface to this volume that it is an attempt to provide botanical students, who already have some knowledge of chemistry, with an introductory account of the chemistry and biological significance of some of the more important substances occurring in plants. During the last few years a great deal of work has been done in the direction of ascertaining the nature and relationships of the compounds which are formed or decomposed in the course of vegetable metabolism, and it is important that the results of this work should be gathered together in such a form that they may be added to the current body of data available for assimilation by students. The accomplishment of such a task requires careful discrimination between fully established facts on the one hand and merely nebulous matter on the other; the former may give the student a clear, though possibly an incomplete picture of what is happening; the latter can only confuse him. In this volume the authors have included some material that is hardly ready for assimilation by students, and they have devoted much space to such matters as descriptions of methods of estimating, isolating, and examining various products, for which the student might have been referred to text-books on chemistry.

The book also needs careful revision on a number of small points. Slightly different names are frequently applied to the same material, *e.g.* "palm-kernel oil" on pp. 29 and 33 and "palm-nut oil" on pp. 32 and 34, "orcin" and "orcinol" on p. 56, "methyl pentoses" on p. 57 and "methylpentose" in the index. On p. 256 it is stated that the Labiatæ are quite free from alkaloids, whilst on the next page, stachydrine, an alkaloid from a plant belonging to this natural order, is referred to.

The authors say in their preface that "although the point of view is in the main purely chemical and botanical, the economic aspect has not been lost sight of." In spite of this there are only incidental references to resins, gum-resins, essential oils, rubber and gutta-percha, all of which are of great interest from the botanical, chemical, and economic points of view. The economic information given is not always quite accurate; for example, the statement on p. 4 that "varnish consists of a mixture of boiled oil with gum resins and oil of turpentine."

In spite of these defects the book is quite a useful publication, since it brings together a great deal of scattered information on a subject which is receiving an increasing amount of attention from scientific workers. It is issued at a reasonable price and is very well produced.

Beurre de Vache et Graisse de Coco. By J. Lahache and F. Marre. Pp. 364, Crown 8vo. (Paris: A. Maloine, 1913.)

This work deals principally with the methods of examination of butter and of butter substitutes manufactured from coconut oil, and also with the important question of the detection of coconut oil in admixture with genuine butter. The book is, therefore, primarily of interest to the analyst. The manufacture and purification of coconut oil for edible use is briefly described, and the legal restrictions imposed in different countries on the manufacture and sale of vegetable butters are discussed.

A rather curious mistake occurs on p. 12 (footnote), where "Ghee" is included in a list of vegetable fats used by natives as food, whereas it is well known to be clarified butter fat. In the same paragraph "Galam," "Shea," "Bambouc," and "Karité" fats are mentioned as if they referred to distinct products, although they are merely local names for the fat obtained from shea nut kernels (*Butyrospermum Parkii*).

The Cane Sugar Factory. A Catechism of Cane Sugar Manufacture for the Use of Beginners. By Frederic I. Scard, F.I.C. Pp. iv + 118, Small 8vo. (London: The West India Committee, 1913.) Price 1*s*. net.; post free, United Kingdom 1*s*. 3*d*., abroad 1*s*. 4*d*.

This work contains 273 questions, each followed by a short answer. They are arranged under the headings of milling, clarification, filtration, concentration, crystallisation, centrifugalling, steam supply, scientific control, and distilling. The answers are in some cases so brief and incomplete as to be unintelligible to those who have no previous knowledge of the subject, and render reference to other works indispensable. A large part of the book is occupied by a series of useful tables of weights, measures, temperatures, specific gravities, etc., and by a glossary of technical terms used in cane-sugar factories. Emphasis is laid on the importance of keeping careful records of results, and a specimen factory record form is appended.

Outlines of Stationery Testing. By H. A. Bromley. Pp. 74, Crown 8vo. (London: C. Griffin & Co., Ltd., 1913.) Price 2*s*. 6*d*. net.; post free, United Kingdom 2*s*. 9*d*., abroad 2*s*. 10*d*.

By far the larger portion of this work is devoted to the examination of paper, physically, microscopically, and chemically, the microscopical section containing six plates

illustrating the various fibres commonly occurring in paper. The remainder of the book deals with the examination of other articles employed in the ordinary course of office routine, including, among others, inks, string, paste, and sealing-wax. In view of the comprehensive character of the work only the more important and recognised methods of examination of each material are given. The absence of unnecessary details and technical terms should enable this volume to fulfil its purpose as a useful and practical guide to stationery testing for persons of limited analytical experience.

THE SHEEP AND ITS SKIN. By Alfred Seymour Jones. Pp. viii + 396, Demy 8vo. (London: The Leather Trades Review, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 10*d.*, abroad 13*s.*

This book deals with the history, breeds, and diseases of sheep, and also with the utilisation of the skins. In the introductory chapters the evolution and history of the sheep, sheep-rearing, and the more important breeds of sheep, are dealt with briefly. The important questions of the diseases of sheep are next discussed, a whole chapter being devoted to "fluke" or "liver rot," so prevalent at times in this and other sheep-rearing countries. The greater part of this chapter consists of a reprint of Prof. Thomas's paper on the liver-fluke, reproduced by permission of the Royal Agricultural Society.

The remainder of the book deals with the utilisation of sheepskins, and includes a large amount of useful information on fell-mongering, the preservation of skins and pelts, and the preparation of pelts for tanning. The appendix consists of an article by J. T. Wood on the bacteriology of the leather industry. A useful feature is the list of works and articles dealing with the subject. The book is intended to be of use to those engaged in the leather and allied trades, and is written, therefore, in a more or less popular style, devoid of abstruse scientific or technical terms. One ventures to suggest, however, that some of the numerous historical references (*e.g.* that commencing on p. 29) might have been omitted or considerably shortened with advantage. Such a statement as the following (p. 95), "The general molecular forces have been nucleating until the whole mass finally becomes crystalline, a change which is further fixed by the hydrolytic processes of liming," is scarcely calculated to help the reader towards a lucid conception of the causes of "colt" or "deadfat" in sheepskins.

Numerous illustrations are given, many of which are whole-page plates, an unusual feature being their inclusion in the numbering of pages throughout, tending to give a somewhat fictitious idea of the size of the book. The

illustrations are on the whole good, but occasionally so bad as to be quite useless, as in the case of the illustrations of the sheep maggot and fly on p. 150. Both printing and paper are inferior for a book of this character and price. Among misprints one might call attention to "shatole" for skatole (p. 116), and "recinolein" for ricinolein (p. 214).

MISSIONS DANS LE KATANGA. I. Le Commerce au Katanga: Influences Belges et Etrangères. By G. de Leener. Pp. xviii + 143. II. L'Agriculture au Katanga: Possibilités et Réalités. By A. Hock. Pp. 305, Crown 8vo. (Bruxelles: Misch & Thron, 1911 and 1912.) Price per vol., 3 francs 50 centimes; post free, United Kingdom vol. i. 3*s.* 1*d.*, vol. ii. 3*s.* 2*d.*; abroad vol. i. 3*s.* 2*d.*, vol. ii. 3*s.* 4*d.*

These two books form respectively volumes 16 and 18 in the group of "actualités sociales" published by the Solvay Institute of Sociology in Brussels. In 1909–10 the Colonial Studies group of that institute chose as its principal subject for discussion the penetration by the Belgians of the portion of the Belgian Congo known as Katanga. The outcome of that discussion, M. Waxweiler explains in a foreword to the first of these two volumes, was the discovery that authoritative information was lacking, and as a result a special mission to Katanga was organised, the funds being provided by M. Ernest Solvay. The two volumes now under notice contain the results of this mission. M. de Leener describes the actual commercial condition of Katanga, and points out that its various enterprises are mainly in the hands of foreigners, chiefly of British nationality. There are two principal reasons for this, viz. the geographical situation of the territory—it is virtually a hinterland of Rhodesia—and the fact that the British, with their great colonising experience, have developed a mentality which discounts risks, whereas the Belgians, not having had such experience, are as yet disinclined to take the serious risks involved in settling in a new country in which industries and commercial enterprises have still to be created.

In the second volume M. Hock discusses in detail the situation, climate, soils, possible crops, agricultural labour, methods of agriculture, possibilities of cattle-raising, and many other subjects bearing on the future agricultural development of Katanga, especially as a field for planters and small farmers of Belgian nationality.

Both volumes are liberally provided with pictures of typical scenes in Katanga and in various British South African territories, the latter apparently being given with a view to creating in Belgium the desire to reproduce such scenes in Katanga. These books are particularly interesting to British readers, since they give the results of a careful study of the methods which have, on the whole,

proved successful in British colonisation. For such studies we have still to rely almost wholly on foreign sources.

A COMMERCIAL GEOGRAPHY OF THE WORLD. By O. J. R. Howarth, M.A. Pp. 236, with 33 diagrams, Crown 8vo. (Oxford: at the Clarendon Press, 1913.) Price 2*s.* 6*d.*; post free, United Kingdom 2*s.* 10*d.*, abroad 2*s.* 11*d.*

This is one of the series of Oxford Geographies, edited by Prof. Herbertson. The mode of treatment adopted is briefly as follows. The influence of climate and relief on commerce and industry is first considered, and the chief products of cold, temperate, and hot lands are enumerated, with brief descriptions of the more important materials. The fisheries and zoological regions of the world are then dealt with, and this is followed by a chapter on the distribution of minerals and the influence of this distribution on the establishment of great industries. The next three chapters deal with the special subjects of (1) transport, (2) trading centres and migration, and (3) the grain trade, with the closely associated subjects of irrigation, crop failure, and famines. In the last eight chapters the actual commercial and industrial condition of the principal regions of the world are considered under the heads of their political divisions.

The arrangement and matter are admirably suited for giving the reader a broad view of the important facts with which commercial geography is concerned.

There are one or two small matters which will need attention when the book comes to be revised for a second edition. The paragraph headed "quinine" on p. 70, for example, does not make it clear that the South American production of cinchona bark is no longer of great importance, and that the world's supply of this drug is principally derived from Java. The statistician, moreover, will be surprised to find that, according to the table on p. 222, the imports and exports of the United States are respectively twice and three and a half times as great as those of the United Kingdom. The explanation of this error appears to be that the figures for the United States purport to be given in £ sterling, but are really given in dollars.

PETROLEUM. By Sir Boverton Redwood, Bart. 3rd Edition. 3 Vols. Pp. xxxii + 367 + 417 + 383, 8vo. (London: C. Griffin & Co., Ltd., 1913.) Price £2 10*s.* net.

The present edition of this familiar and standard treatise on petroleum has been prepared with the co-operation of W. H. and L. V. Dalton, A. W. Eastlake, J. Wishart, R. Redwood, V. B. Lewes, A. Cooper-Key, and others. Former editions were in two volumes. Since the issue of the second edition (pp. xxxii + 1064) in 1906 (see this

BULLETIN, 1906, **4**, 368) extensive developments have taken place in the production and utilisation of petroleum, and this fact finds expression in the new edition of Sir Boverton Redwood's treatise, which, as readers of former editions know, is very comprehensive in scope.

Vol. 1 gives a historical account of the petroleum industry, and deals with the geological and geographical distribution, the physical and chemical properties, the origin and production of petroleum and natural gas. In vol. 2 the subjects dealt with are the refining of petroleum; the shale-oil and allied industries; the transport, storage, and distribution of petroleum; the testing of crude petroleum, petroleum and shale-oil products, ozokerite and asphalt; the uses of petroleum and its products. Vol. 3 gives an account of regulations relating to the testing, storage, transport, and use of petroleum and its products, and has various appendices dealing with statistics, marine transport, import duties, and bibliography.

The treatise is richly supplied with maps, plates, and illustrations, and these have shared in the revision and addition which has affected most parts of the work. The continued co-operation of many specialists in the work of revision is a pleasing feature, which adds greatly to the value of the work, and gives the reader confidence.

The bibliography, which is a valuable section, has grown from 5,904 items and 113 pages in the second edition to 8,804 items and 163 pages in the present edition. The index has been considerably diminished in bulk, but greatly improved in quality. The masses of figures without descriptive references, which marred the old index, have given place to a classified and more convenient arrangement.

The author and his co-workers are to be congratulated on the results of their work of revision, but there is still room for improvement. It seems hardly necessary to put on record some of the occurrences and rumours of occurrences of petroleum that are given in this treatise. The historical, geographical, and geological sections of vol. 1 need serious revision. Much that is unimportant might be omitted from these sections, and a more systematic treatment of these portions of the volume would still further enhance the value of an already valuable treatise on petroleum.

THE MINING WORLD INDEX OF CURRENT LITERATURE. Vol. ii., 2nd half-year, 1912. By G. E. Sisley. Pp. xxiv + 234, Med. 8vo. (Chicago: The Mining World Company, 1913.) Price $1.50; post free, United Kingdom 6*s.* 7*d.*, abroad 6*s.* 10*d.*

This is an international bibliography of mining, compiled and revised semi-annually from the weekly index

of the world's current literature published by the *Mining and Engineering World.* The subjects dealt with include metals and metallic ores, non-metals, mines and mining, mills and milling, metallurgy and chemistry, power and machinery. Readers of the *Mining and Engineering World* already realise the value of the bibliography which the journal publishes periodically, and they will no doubt appreciate the issue, in this handy form, of a work of reference which should prove very useful.

THE AMERICAN FERTILIZER HANDBOOK, 1913. Pp. 354, 4to. (Philadelphia, U.S.A.: Ware Bros. Company, 1913.) Price $1 post free.

This handbook contains lists of manure manufacturers, of cottonseed-oil mills, and of makers of machinery, chemicals, and other products used in the preparation of artificial manures. The lists refer to the United States only for the most part, but a few names are included for Canada, the West Indies, and Hawaii.

In addition a number of special articles on the manufacture of certain kinds of manures are published, as well as a great deal of statistical, commercial, and technical information of interest to those who either manufacture or use artificial manures.

THE TROPICAL AGRICULTURIST: Journal of the Ceylon Agricultural Society. Published monthly. Crown 4to. (Colombo: Messrs. H. W. Cave & Co.; London: Messrs. Maclaren & Sons, Ltd.) Annual subscription, Ceylon Rs. 8 (10s. 8*d.*), abroad £1 post free.

This well-known publication, which was founded in 1881 by Mr. John Ferguson, C.M.G., and which has been the official magazine of the Ceylon Agricultural Society since 1905, has recently been acquired by the society. Five numbers (March to July 1913) have so far been published under this new arrangement. In addition to recording the work of the society, the *Journal* contains original articles mostly on subjects of special interest to Ceylon, whilst the inclusion of numerous extracts from other publications enables the reader to keep well informed on all matters relating to tropical agriculture. Amongst recent original articles mention may be made of that on paddy cultivation in Ceylon during the nineteenth century, in the March number; and those on tobacco culture in the Northern Province, Ceylon, and the rubber industry in Java, in the June number.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

THE UTILISATION OF PARA RUBBER SEED.—II.

REFERENCE has already been made in this BULLETIN (1903, **1**, 156; 1904, **2**, 22; 1909, **7**, 95; 1911, **9**, 35) to the utilisation of Para rubber seed kernels as a source of oil and feeding cake.

In order to ascertain the value of the oil for various industrial purposes, samples have been distributed by the Imperial Institute to a number of firms for technical trial. It has been pointed out already (*loc. cit.*) that the cake left after expressing the oil from the kernels would probably be suitable for use as a feeding-stuff, and with a view to confirming this by actual feeding trials, supplies of the cake have been forwarded to the South-Eastern Agricultural College, Wye, so that feeding trials might be made. The results so far obtained in these two technical investigations are summarised in the following pages, to which are added the results of examination of samples of the kernels, cake, and oil forming part of experimental consignments. An account of previous samples examined at the Imperial Institute is given in this BULLETIN (1903, **1**, 156; 1911, **9**, 286).

TECHNICAL TRIALS OF THE OIL

Paint and Varnish Manufacture.—Samples of the oil were furnished to three firms for trial in the manufacture of paints and varnishes. One firm stated that the oil

proved very satisfactory for their purposes, being about equal to linseed oil. They added, however, that their experiments were not carried on long enough to determine whether paint made with Para rubber seed oil lasts as long as that made with linseed oil, but they would not hesitate to adopt it in part of their manufactures, provided it was obtainable at an acceptable price. They stated that they would be prepared to pay 25*s.* to 30*s.* per cwt. for the oil if it were obtainable in considerable quantity (July 1912).

A second firm stated that the drying power of the oil was 30–40 per cent. less than that of linseed oil. They found that it dried with a "flatter" surface and considered that it would not show as good results in paint as linseed oil.

In the third case the oil was found to dry more slowly than linseed oil with the usual "driers" and to be more readily saponifiable than the latter oil. The opinion was expressed that as linseed oil was quite satisfactory for paint and varnish manufacture, it was unlikely that it could be replaced by Para rubber seed oil as long as it was obtainable at reasonable prices and in large quantities.

Linoleum Manufacture.—Four separate trials have been made with the oil for this purpose.

A German firm stated that Para rubber seed oil is not completely satisfactory as a substitute for linseed oil in the manufacture of linoleum, but that more extensive trials are necessary before a definite conclusion could be reached. They would, however, be prepared to consider the matter if the price of the oil were less than that of linseed oil.

In a second case the results were stated to be unsatisfactory. Some difficulty was experienced in drying the oil, and two manufacturers, who were supplied with samples of the oil by the firm conducting this trial, considered that it is of very little value for this trade.

Another firm stated that the iodine value of the oil is much too low to enable it to be used as a substitute for linseed oil for the manufacture of linoleum, but they expressed the opinion that it might take the place of soy bean oil for making paint oils, but this would depend on its price.

The fourth firm also considered it to be unsuitable for linoleum manufacture.

Soft Soap Manufacture.—A firm of oil seed crushers stated that the oil would be very suitable for the manufacture of soft soap, and for this purpose would be about equal in value to linseed oil or cotton seed oil.

Manufacture of Rubber Substitutes.—One firm to whom a sample of the oil was submitted thought that it would probably be suitable for the manufacture of rubber substitutes, but a second firm stated that their experiments did not show that the oil could be employed to any advantage for this purpose.

Conclusions

It has been pointed out previously in this BULLETIN (*loc. cit.*) that though Para rubber seed oil is a drying oil it dries less quickly than linseed oil and is therefore inferior to this oil for those industrial uses to which linseed oil is particularly suited. When linseed oil is high in price, however, it has to be replaced by oils that are intrinsically inferior to it for these purposes, and in such cases Para rubber seed oil would be a valuable substitute. The defects of Para rubber seed oil from this particular point of view are, however, advantages for other industrial purposes, since they enable it to be used to some extent in industries in which the employment of linseed oil is inadmissible. On the whole, the results of these trials clearly indicate that there would be no difficulty in finding a market for Para rubber seed oil, provided it can be put on the market at a suitable price and in large quantities. In this connection mention may also be made of the fact that the new process of "hardening" liquid oils by hydrogenation, if successful on an industrial scale, will open an entirely new market to oils of the Para rubber seed type (see p. 660).

FEEDING TRIALS WITH PARA RUBBER SEED CAKE

Two series of feeding trials have been carried out at the South-Eastern Agricultural College, Wye, with Para rubber seed cake, which formed part of commercial consignments imported, or made experimentally in this country and

courteously furnished to the Imperial Institute by the importers.

First Series

About 4 cwts. of cake imported from Rangoon were received in February 1911. A portion was analysed at the Imperial Institute and gave the following results, to which is added for comparison the average composition of linseed cake:

	Para rubber seed cake. *Per cent.*	Linseed cake. *Per cent.*
Moisture	6·91	11·6
Crude proteins	29·93	29·50
Consisting of:		
True proteins	27·03	—
Other nitrogenous substances	2·90	—
Fat	17·68	9·50
Starch, etc. (*by difference*)	35·97	35·54
Fibre	4·82	9·10
Ash	4·69	5·20

The ash contained:

		Per cent.
Lime	CaO	5·03
Phosphoric acid	P_2O_5	33·52
Potash	K_2O	34·89

No saponin or alkaloids were present in the cake, and if any cyanogenetic glucosides were present the amount was less than that necessary to yield 0·01 per cent. of hydrocyanic acid.

It should be pointed out that this consignment of Para rubber seed cake was not of normal composition, inasmuch as it contained nearly 18 per cent. of fat, which is at least twice as much as would be left in the cake under ordinary commercial conditions. The composition of the second consignment (see p. 555) more closely represents the cake which would be marketed under ordinary conditions when the kernels are being expressed regularly on a large scale.

The report on the feeding trials conducted at Wye with this consignment of cake was as follows:

Cows.—A quantity of the cake was moistened and fed to cows. All except three, which are usually averse to new foods, ate it readily. The cake was dry and powdery,

and was moistened before feeding for this reason. It was found to absorb about its own weight of water, and was more appetising in this state than when fed dry. Several cows refused it in the dry state, but ate it readily when moist.

Three cows received the cake daily for five days, getting 4 lb. each day. They all ate it readily, and no scouring or binding effects were noticed, nor did the milk or cream appear affected in any way.

Sheep.—The cake was fed in a dry state to sheep and was eaten fairly readily. Some sheep ate their full allowance when it was mixed with other foods, but apparently had less liking for it when fed alone. No exceptional effects were noted.

Second Series

A more extended feeding trial with 1½ tons of Para rubber seed cake, made experimentally from kernels imported from Ceylon, was carried out at the South-Eastern Agricultural College during the latter part of 1912 and the beginning of this year. A sample from this consignment was examined at the Imperial Institute and gave the following results, which are compared with the average figures for linseed cake :

	Para rubber seed cake. *Per cent.*	Linseed cake. *Per cent.*
Moisture	8·75	11·6
Crude proteins	30·19	29·50
Consisting of :		
True proteins	24·85	—
Other nitrogenous substances	5·34	—
Fat	8·71	9·50
Starch, etc. (*by difference*)	41·74	35·54
Fibre	5·01	9·10
Ash	5·60	5·20
Nutrient ratio	1 : 2·0	1 : 2·0
Food units	139	133

Cyanogenetic glucosides were present in this sample, which yielded approximately 0·02 per cent. of hydrocyanic acid.

This cake probably represents fairly closely the

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material which would be marketed if Para rubber seed kernels were worked industrially on a large scale, and its composition may therefore be fairly discussed in comparison with that of linseed cake, which is the feeding cake chiefly used in the United Kingdom.

It will be seen from the foregoing table that Para rubber seed cake is strikingly similar to linseed cake in composition, and that what difference there is, is in favour of the former. The chief difference is in the quantity of "fibre," which is only 5·01 per cent. in the case of Para rubber seed cake, against 9·10 per cent. in linseed cake. It is to be remembered, however, that the item "starch, etc." is a "difference" figure, and probably represents to a large extent different carbohydrates in the two cases. Thus in the case of linseed there is much mucilage, which accounts to some extent for the hardness of linseed cake. Para rubber seed cake, on the contrary, is soft and inclined to crumble easily, so that it probably contains but little mucilage. Like linseed cake, Para rubber seed cake may yield small amounts of prussic acid, and the amount furnished by this sample is rather high, but as will be shown later it produced no ill effects on the animals fed with the cake.

The following is a summary of the report received on the feeding trials conducted at Wye with this cake:

Sheep.—A group of store tegs accustomed to trough feeding were used for the experiment. The smallest admixture of the rubber seed cake with the usual concentrated foods was, however, detected by the sheep, and the cake was left uneaten. Even when the total food supplied to the sheep was reduced below maintenance requirements, and this low ration was continued for a fortnight, the sheep refused to eat the rubber seed cake. Mixtures of the cake and various other concentrated foods were also tried without success. Older sheep similarly refused the food, and in fact all attempts at feeding sheep with this sample of Para rubber seed cake failed.

Young Cattle.—The cake was fed to a pair of two-year-old fattening heifers, which readily ate the food. The quantity of cake was increased gradually to 8 lb. per head per day, but this caused pronounced scouring, and even

5 lb. of Para rubber seed cake eaten daily with 56 lb. of mangolds produced a slightly laxative effect on these immature animals; the latter quantity of cake should therefore not be exceeded, as a rule, for such cattle. Further experiments with another batch of two-year-old beasts confirmed this conclusion.

Two of the beasts were killed at the conclusion of the experiment; the butcher reported the carcases to be of first-class quality, and the beef of excellent flavour. One of these heifers had received 6 lb. of the cake per day for ten weeks.

Dairy Cows.—Six barren cows with an average milk yield of 1½ gallons per day were used for this test, and were fed with increasing amounts of the cake, until at the end of a week each animal was receiving 14 lb. of cake per day. The cake was the only concentrated food supplied to the animals, and the ration was continued for six days without any marked change in the animals' excreta. The ration being richer than that previously allowed, the yield of milk rose, but the percentage of fat in the milk was practically unchanged. Butter was made from the milk produced during the first three days and again from that of the second three, and in each instance the texture, smell, and flavour of the butter were considered to be unaffected by the change of concentrated food. The butter was of slightly paler colour than that obtained from the same cows on a concentrated food ration of bran, dried grains, oats, and Egyptian cotton seed cake.

Para rubber seed cake can thus be safely fed to dairy cows without fear of tainting the milk or adversely influencing the butter. Even the large quantity of 14 lb. per head per day seems to be without noticeable effect when fed to mature cattle.

Full-grown Fattening Cattle.—The cows mentioned above were fattened while still in milk, the daily quantity of rubber seed cake being reduced from 14 lb. to 8 lb., and 4 lb. of other cake added. The cows remained in a very healthy condition, and maintained a high milk yield until they were intentionally dried off about a month before sale to the butcher. The increase in live weight over an

average fattening period of nine weeks was 1·7 lb. per cow per day, and the milk yield over the same period was 0·85 gallon per cow per day, the cows being in milk an average of six only of the nine weeks. Para rubber seed cake thus appears to be a valuable fattening food for cows, producing very satisfactory increases in weight in mature animals, and giving rise to no ill effect even when the feeding is continued for a considerable time.

The value of Para rubber seed cake as a food for cattle has been clearly established by these experiments. As the first sample of Para rubber seed cake was eaten fairly readily in a dry state by sheep (see p. 555), it would appear that the aversion of sheep to the second sample must have been due to some peculiarity which it possessed, or to some idiosyncrasy in the sheep used, and it will not be desirable to draw a definite conclusion as to the unsuitability of Para rubber seed cake as a food for sheep without further trials.

Commercial Consignments of Para Rubber Seed Kernels

As a result of the work done at the Imperial Institute on Para rubber seed kernels, a considerable amount of interest in this product has been aroused among planters in Ceylon and the Federated Malay States, and among oil seed crushers and others in the United Kingdom, and several experimental consignments of the kernels, oil, and cake have been received and sold in the United Kingdom. The following particulars of such a consignment of kernels crushed in the United Kingdom are of interest in this connection.

"*Kernels as received from Colombo.*"—This consisted of dried kernels in fair condition, though a few damaged kernels were present. On examination at the Imperial Institute the kernels were found to yield 45 per cent. of a pale yellow liquid oil with an acid value of 34·1.

"*Cake as received from the crushers.*"—This consisted of clean, friable, buff-coloured cake, which was found to contain 11·2 per cent. of a semi-solid oil, obviously composed principally of free fatty acids.

"*Extracted oil.*"—This was a clear, liquid, brown oil, which gave the following results on examination, compared with those for samples of Para rubber seed oil from kernels in good condition previously examined at the Imperial Institute:

	Present sample.	Previous samples.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$.	0·925	0·925 to 0·930
Acid value	40·9	10·7 to 16·8
Saponification value . .	188·5	191·8 to 192·1
Iodine value . . *per cent.*	143·3	128·3 to 131·4

The oil thus generally resembled the samples previously examined at the Imperial Institute. Its acidity, however, was high, and this factor was apparently the cause of the "feeding up" stated to have been observed in paint made with the oil. Experiments carried out at the Imperial Institute support this view, since the oil as received, when ground with white-lead, gave a pasty, stiff paint which did not spread well, whilst oil from which the free acid had been removed gave a paint which remained fluid and could be spread easily.

It has been found at the Imperial Institute that the acid value of the oil is usually higher when the latter has been prepared from old or damaged kernels, and it is possible that the rather high acid value in this instance is due to the use of kernels that had been stored for some time. The acidity is principally due to the condition of the seed which yielded the oil (see above); the increase from 34·1 to 40·9 being probably due to enzyme action during the crushing process.

The oil did not appear to contain any lipolytic enzyme, as its acidity did not increase on keeping, even under conditions favourable for the action of an enzyme.

SOME NEW OR LITTLE-KNOWN OIL SEEDS AND OILS

As a consequence of the high prices prevailing in recent years for most of the fixed oils and fats of commerce, much interest is being shown, especially in the British tropical

dependencies, in the possibility of exploiting oil seeds of various kinds for export. A considerable number of such products have been examined during the last few months at the Imperial Institute, and the more interesting of these are dealt with in the following series of reports:

SAFFLOWER SEED FROM NYASALAND

The safflower, *Carthamus tinctorius*, L. (natural order, Compositæ), has been cultivated from ancient times in India, China, Egypt, Turkestan, and elsewhere, chiefly for the sake of its flowers, which yield the well-known rose-coloured dye. In parts of India, however, it is grown solely for its seeds, which yield an oil largely used locally for culinary purposes, the inferior qualities being used for burning. It is the most important oil seed cultivated in Bombay, from 500,000 to 600,000 acres being grown annually in association with juar (sorghum), wheat, or gram. Considerable quantities of the seed are exported from India.

The plant has been grown experimentally in Nyasaland for the sake of its seeds, and a sample of these, stated to be grown from Egyptian seed, was received for examination in July 1912.

The sample consisted of small white seeds, quite similar to Indian safflower seed of commerce. The seed, as received at the Imperial Institute, contained 5·7 per cent. of moisture, and yielded 29·6 per cent. of clear yellow oil. Safflower seed generally contains 30 to 32 per cent. of oil.

The seed was submitted for valuation to a firm of oil seed crushers, who reported that the sample was in good condition, and that it closely resembled the average quality of Indian safflower seed sold on the London market, except that the percentage of moisture present was somewhat higher. The firm stated that for the last few months there had been no trade in this product, and it was therefore impossible to quote a current price, but they considered that its value to oil seed crushers would probably be about £7 10s. per ton, less 2½ per cent. discount, delivered ex ship London (February 1913).

The firm added that oil seeds of this kind naturally find a better market when high prices are prevailing for linseed,

as has been the case during the last two or three years, though the price has now fallen to a little above the normal level.

Amoora Rohituka Seeds from India

Amoora Rohituka, W. and A. (natural order, Meliaceæ), is an evergreen tree found in Northern and Eastern Bengal, and Assam, where it is known as "raina." The oil is used locally for medicinal purposes and for burning.

A small sample of raina seeds was received from Bengal in July 1911. It consisted of nearly round, brownish-black seeds, with narrow pale brown hilum and a thin and brittle husk, which adhered to the kernel. The average weight of a single seed was about 0·7 gram. The kernels were firm, white or pale yellow, and had a nauseous, bitter taste.

The entire seeds yielded 42·5 per cent. of a viscous, clear, yellow-brown oil, with an unpleasant smell and a bitter taste.

A larger supply of the seeds was received from Bengal in August 1912. The entire seeds contained 7·5 per cent. of moisture, and yielded 43·5 per cent. of oil similar to that obtained from the previous sample. On standing, it deposited a little crystalline solid matter.

The oils obtained from these seeds were examined with the following results:

	Sample received in 1911.	Sample received in 1912.
Specific gravity at $\frac{15{\cdot}5^\circ \text{C.}}{15{\cdot}5^\circ \text{C.}}$	0·929	0·931
Solidifying point of fatty acids	—	32·4° C.
Acid value	19·6	24·7
Saponification value	193·0	192·3
Iodine value . . . . *per cent.*	132·5	131·7
Hehner value	—	92·4
Insoluble fatty acids . *per cent.*	—	91·0
Unsaponifiable matter . *per cent.*	—	1·4
Volatile acids, soluble	—	1·2
„ „ insoluble	—	0·55

A portion of the second supply was submitted to a firm of oil seed crushers, who stated that the oil extracted from them would be of fair quality for soap-making, but that its flavour and acidity would render it unsuitable for edible use. They stated that the residual cake would be useless

for feeding cattle on account of its bitter taste, and that the low percentage of nitrogen which it contains would render it of very little value as manure. In these circumstances, the seed is chiefly valuable on account of the fairly high yield of oil, and the firm considered it to be worth nominally about £9 per ton in the United Kingdom (April 1913) (see also p. 564).

Eruca sativa Seeds from India

E. sativa, Mill., is an erect herb, closely allied to the mustards (natural order, Cruciferæ). It is a native of South Europe and North Africa, and is extensively cultivated as a cold-season crop in Upper India, being the commonest of the mustard tribe cultivated in Sind. The plant is largely used in India as a green fodder, especially when grown with gram or peas, and the oil cake is much appreciated in that country for feeding cattle. It is grown in India usually as a substitute for rape, and the oil expressed from the seeds is used by the natives mainly as an illuminant and to some extent for food.

A sample of the seeds described as "taramani seeds" was received at the Imperial Institute from Bengal in July 1911. The seeds were very small, and brown or dark grey in colour; 100 seeds weighed 0·25 gram. The sample also contained some linseed.

The seeds yielded 30·8 per cent. of clear, yellow oil, with a slightly mustard-like smell and taste. The oil was examined with the following results, compared with those previously recorded:

	Present sample.	Results recorded by Crossley and Le Sueur.
Specific gravity at $\frac{15{\cdot}5^\circ C.}{15{\cdot}5^\circ C.}$	0·915	0·915 to 0·917
Acid value	2·4	—
Saponification value	175·7	169·0 to 174·1
Iodine value . . . *per cent.*	101·6	97·4 to 99·7

This oil could probably be used for the same purposes as rape and colza oils, and the seed has occasionally been imported into the United Kingdom as a substitute for rape seed. The latter, however, usually contains 33 to 45 per cent. of oil, so that seed yielding only 30·8 per cent. of oil,

as in the present case, would not be as valuable as rape seed. The sample under report also contained an undesirable amount of linseed. A firm of oil seed crushers valued the seed at about 40*s.* per quarter of 416 lb., delivered to any European port (January 1912). The price of rape seed at that date was 49*s.* 3*d.* per quarter in London for February delivery.

Calophyllum Inophyllum Seeds and Kernels from India

This evergreen tree (natural order, Guttiferæ) occurs over a wide area in the tropics, being found in various parts of India, Ceylon, Malaya, Polynesia, Australia, and East Africa. The oil is fairly extensively used by natives in India for burning. It is said to be exported from Southern India to Burma.

A small sample of the seeds described as "panang seeds" was received from Bengal in July 1911. They were brown or brownish-black in colour, almost spherical, and about ¾ to 1 in. in diameter. The shells were thin, woody, and easily broken, and had a thick layer of brown pithy substance adhering to the inner surface. The kernels were round, whitish, and soft, and also somewhat moist, containing about 13 per cent. of moisture. The average weight of a single seed was about 4·1 grams. The kernels yielded 55·0 per cent. of viscous, green oil with a slight bitter taste. On standing the oil turned cloudy, owing to the deposition of white crystalline matter.

A large supply of panang kernels was received from Bengal in August 1912. They closely resembled the kernels extracted from the previous sample of panang seeds, but they contained 3·3 per cent. of moisture, and yielded 71·4 per cent. of oil, as compared with 55·0 per cent. for the previous sample. This difference, however, is largely explained by the drier condition of the present sample of kernels. The oil was viscous, greenish-yellow, semi-solid at the ordinary temperature, and of stiffer consistency than the oil from the previous sample, probably owing to the higher percentage of free acids present.

The results of examination of the oil from these samples were as follows:

	Sample received in 1911.	Sample received in 1912.
Specific gravity	0·950 (at 15·5° C./15·5° C.)	0·880 (at 100° C./15·5° C.)
Solidifying point of fatty acids	—	36·3° C.
Acid value	45·9	77·5
Saponification value	192·8 to 202·9	194·9
Iodine value . . . *per cent.*	97·7	93·1
Hehner value	—	94·3
Insoluble fatty acids . *per cent.*	—	92·9
Unsaponifiable matter . *per cent.*	—	1·4
Volatile acids, soluble	—	0·50
" " insoluble	—	0·45

The kernels were submitted to a firm of oil seed crushers, who stated that they would be of high commercial value on account of the large percentage of oil they contain. The oil is of excellent quality for soap-making, but would be useless for edible purposes if the acid value were as high as in the present sample. The residual cake would probably only be suitable for manurial use, for which purpose it might be worth £2 per ton, or possibly slightly more. The firm stated, however, that even on this basis the kernels, if containing as much oil as this sample, should be worth £16 per ton in the United Kingdom (April 1913).

The firm of oil seed crushers who valued this sample of panang kernels as well as the raina seeds (see p. 562), stated that in both cases they had calculated the price of the oil at its value for soap-making only, on account of the high acid value. They considered, however, that it was just possible that the fresh seeds or kernels, shipped and handled quickly, might arrive at the crushing mills in sufficiently good condition to enable oils of better quality to be obtained, in which case it would be worth while to consider the possibility of using the oils for edible purposes. If this proved feasible the values of the seeds would eventually be higher than those now indicated.

Calophyllum Inophyllum Kernel Oil from Fiji

A sample of oil described as "ndilo" oil, from the seed of *C. Inophyllum*, was received from Fiji in April 1913.

It consisted of a viscous oil, with an unpleasant smell.

The colour was a deep blue, probably owing to contact with some iron vessel during preparation, as iron was found to be present in the oil, and oils of *Calophyllum* sp. are known to give a blue colour with iron compounds.

It had the following constants:

Specific gravity at $\frac{15.5° C.}{15.5° C.}$		0·951
Acid value		65·5
Saponification value		199·5 (approx.)
Iodine value	*per cent.*	96·2

If ndilo oil is to be exported from Fiji care will have to be taken to avoid the formation of the dark blue colour characteristic of the present sample, as such dark-coloured oil, if saleable at all, would only realise low prices. Oil extracted from *C. Inophyllum* kernels from India at the Imperial Institute was of a pale greenish-yellow tint (see p. 563).

It would probably be more practicable to export the kernels from Fiji than the oil.

Mesua ferrea Seeds from India

M. ferrea, L., the ironwood of Assam (natural order, Guttiferæ), is an evergreen tree found wild in the mountains of North-eastern and Southern India, Burma, the Andamans, and Ceylon, and is cultivated in various parts of India. The oil is used by the natives for burning and for medicinal purposes.

A small sample of the seeds labelled "nahar seeds" was received from Bengal in July 1911. It consisted of brown, shining seeds of irregular shape (in many cases pear-shaped), with brittle woody shells and kernels of a dark buff colour. Some of the kernels were mouldy. The average weight of a single seed was about 3·9 grams. The seeds consisted of kernel 56 per cent., shell 34 per cent. The kernels yielded 76 per cent. of oil, equivalent to a yield of about 49 per cent. from the whole seed. The oil was reddish-brown with a curious sweetish odour and a slight unpleasant taste. On standing for a few days at about 15° C. it became semi-solid.

A further supply of the seeds was received from the

Superintendent of the Central Farm, Dacca, in April 1913. It resembled the previous sample, but some of the seeds contained mouldy kernels; about 16 per cent. of those examined had been attacked by insects. The seeds consisted of approximately 61 per cent. kernel and 39 per cent. shell. The sound kernels contained 3 per cent. of moisture, and yielded 75·6 per cent. of oil, equivalent to about 46 per cent. of oil from the whole seed. The oil was dark reddish-brown, somewhat viscous, and became pasty and semi-solid when cooled. The cold oil had a slight odour, which became stronger and somewhat unpleasant on warming. It had a bitter taste.

The oil obtained from these two samples of seed was examined with the following results:

	Sample received in 1911.	Sample received in 1913.
Specific gravity	0·935 (at 15·5° C./15·5° C.)	0·932 (at 100° C./15·5° C.)
Solidifying point of fatty acids	—	30·5° C.
Acid value	20·1	16·2
Saponification value	204·0	204·9
Iodine value . . . *per cent.*	90·0	92·2
Hehner value	—	91·9
Insoluble fatty acids . *per cent.*	—	90·5
Unsaponifiable matter . *per cent.*	—	1·4
Volatile acids, soluble	—	6·7
,, ,, insoluble	—	0·4

This oil resembles in its chemical characteristics the samples previously examined by Hooper in India. Its colour, smell, and taste would render it unsuitable for use as an edible oil, but it could be used for burning or lubricating, and probably for soap and candle manufacture.

The seeds were submitted to a large firm of oil seed crushers for valuation. After conducting technical trials, they reported that probably the only use for the oil would be for soap manufacture, for which purpose it might be expected to realise from £25 to £27 per ton in the United Kingdom (July 1913).

The residual cake has a bitter flavour, and in view of the fact that the kernels of *M. ferrea* are stated (see *Bull. Inst. Botan. Buitenzorg*, 1904, **21**, 4) to contain a poisonous resin acid, which is soluble in the oil and appears to

act as a heart poison, the cake could not be utilised as a feeding-stuff.

Assuming, however, that the cake were valueless (its manurial value being in any case very small), the whole seeds would be worth £10 to £11 per ton in the United Kingdom, and the kernels £17 to £18 per ton.

It appears likely that the foregoing prices would render it possible to export nahar seeds in commercial quantities from India, and information has been requested as to the possibility of shipping consignments for sale in London. It would be preferable to export the kernels, and not the entire seeds, as the shells are of no commercial value, and would add considerably to the cost of transport.

Telfairia pedata Seeds from Uganda

A sample of the seeds of *T. pedata*, Hook. (natural order, Cucurbitaceæ), was received from Uganda in August 1912.

The seeds were flat, irregularly circular, about 1¼ to 1½ in. in diameter, and covered with a tough fibrous layer. They averaged 5·8 grams in weight, and consisted of fibrous husk 8·7 per cent., shell 36·6 per cent., and kernel 54·7 per cent. The kernels contained 4·6 per cent. of moisture, and yielded 62·9 per cent. of viscous, reddish-brown oil.

The seeds of *T. pedata* furnish a non-drying oil which would be suitable for soap-making. The shells, however, contain an intensely bitter substance, which finds its way into the oil when the entire seeds are crushed, so that the oil thus obtained could not be utilised for edible purposes, and the residual cake would be unsuitable for use as a feeding-stuff. An oil of better quality could be obtained by crushing the kernels alone, but so far no machine has been devised capable of removing the fibrous husk and the hard shell.

Further information regarding the commercial utilisation of these seeds will be found in an article on the subject in this Bulletin (1912, **10**, 223).

Illipe Oil from Mauritius

A sample of illipe oil derived from the kernels of *Bassia latifolia* was received from Mauritius in November 1912.

The Bassias are well-known Sapotaceous plants, the kernels of which are largely exported from India under the name of "mowra" seeds. The fats obtained from the kernels of *B. latifolia*, *B. longifolia*, and *B. butyracea* have already been investigated at the Imperial Institute (this BULLETIN, 1911, **9**, 228), the material being obtained from India and Ceylon, whilst the fat of a form of *B. Mottleyana* from British North Borneo has also been examined (this BULLETIN, 1912, **10**, 549).

The present sample from Mauritius was stated to be manufactured at Port Louis, 100 kilos of shelled nuts yielding 16·34 litres of pure oil, *i.e.* about 15 per cent.

Six bottles of the oil were forwarded, each containing a yellow fat and a quantity of liquid, yellow oil. On mixing the fat and the oil a homogeneous pasty yellow fat was obtained, which had a very faintly rancid taste.

The results of examination of the oil were as follows, compared with oil extracted at the Imperial Institute from the kernels of *B. latifolia* from India:

		Present sample.	Oil extracted from kernels of *B. latifolia* at the Imperial Institute.
Specific gravity at $\frac{100° C.}{15·5° C.}$		0·861	0·862
Solidifying point of fatty acids		37·9° C.	43·2° C. to 46·0° C.
Acid value		20·3	—
Saponification value		196·2	188·3 to 195·3
Iodine value	*per cent.*	52·6	56·7 to 61·5
Hehner value		95·3	94·2 to 96·4
Insoluble fatty acids	*per cent.*	95·01	—
Unsaponifiable matter	*per cent.*	0·29	2·0 to 3·5
Volatile acids, soluble		0·55	0·2 to 0·9

Samples of the fat were submitted for valuation to soap manufacturers and to makers of edible fats. One of the soap-making firms reported that the fat yielded a good, hard, yellow soap, and that for this purpose it would realise about the same price as good palm oil, the value of which then varied from £27 to £30 per ton in Liverpool (May 1913). A second firm also described the product as a good soap-making fat, though they added that it could not be used to replace high-grade tallow.

With reference to the suitability of the fat for edible use,

the experts who were consulted were of opinion that it was unlikely to be of any value for this purpose.

This illipe fat from Mauritius is somewhat softer than specimens from other sources examined at the Imperial Institute, the solidifying point of the fatty acids being rather low. This may be due to the method of preparation, as it is obvious from the low yield obtained (only about 15 per cent.) that the extraction of the fat was far from complete. *B. latifolia* kernels have usually been found to contain from 45 to 55 per cent. of fat.

Unless the kernels are treated by efficient crushing machinery, so that a satisfactory yield of fat is obtained, it would be more profitable to export the dried kernels than the fat. The present value of "mowra" kernels (*Bassia* spp.) from India is about £11 per ton in the United Kingdom (June 1913), and there is a large market for this product.

Pentadesma butyracea Fruits and Kernels from West Africa.

P. butyracea, Don (natural order, Guttiferæ), the "butter or tallow tree" of Sierra Leone, is a fairly large tree confined to West Africa, being found from Sierra Leone southwards to beyond the equator. It is said to be very common in the southern part of the Epe, Jebu Ode, and Ondo districts of the Western Province, Southern Nigeria, as well as in the Forcados district of the Central Province. It occurs in the most humid parts of the tall evergreen forests throughout the south-west of the Gold Coast Colony, as a rule being restricted to the crests and slopes of gentle undulations, and is not found on the highest ground or in marsh land.

The fat is extracted from the seeds by the natives in some parts of West Africa, and is used for cooking purposes. A sample of this fat from Sierra Leone was examined at the Imperial Institute in 1908 (see this Bulletin, 1908, 6, 375), and samples of the kernels from Southern Nigeria, and of the fruits and kernels from the Gold Coast, have been received recently for investigation.

Southern Nigeria

A small supply of the kernels was received from Southern Nigeria in April 1911. It consisted of large brown kernels, irregular in shape and dirty pink to brown internally. The kernels were very moist when received, and on drying in the air they lost about 34 per cent. of their original weight. The air-dried kernels averaged 12 to 13 grams each in weight, and then contained 10·6 per cent. of moisture and yielded 40 per cent. of fat. The latter was of a pale yellow colour and had a pleasant smell and taste.

The fat was examined with the following results, compared with the fat of *P. butyracea* from Sierra Leone, previously examined (*loc. cit.*):

	Present sample.	*P. butyracea* fat from Sierra Leone.
Specific gravity at $\frac{15·5° C.}{15·5° C.}$	0·857	0·859
Acid value	3·1	3·6
Saponification value	186·0	190·1
Iodine value . . . *per cent.*	46·5	41·8

A sample of the kernels was submitted to a firm who had applied to the Imperial Institute for information regarding the possibility of obtaining commercial supplies of the kernels. They reported that samples of *P. butyracea* kernels, which they had examined, showed considerable variation in the yield of fat, largely owing to imperfect drying and differences in the degree of ripeness. They also stated that the fat is highly coloured and needs refining before it can be used to advantage in soap-making, whilst the residual cake is of no value as a feeding-stuff for cattle. In view of these facts they considered that the value of *P. butyracea* kernels would probably be £8 to £10 per ton in the United Kingdom, if imported in good, dry condition.

Gold Coast

The following samples of the fruits and kernels of *P. butyracea* were received from the Gold Coast in October, 1912:

1. Fruits collected in middle of August 1912.
2. Fruits collected at end of September 1912.
3. Kernels collected in middle of August 1912.

4. Kernels collected in middle of September 1912.

5. Kernels collected at end of September 1912.

The fruits were lemon-shaped, averaging 5 to 6 in. in length, and 2½ to 3½ in. in diameter. The colour was dark brown. Each fruit contained about eight kernels, surrounded by dark-coloured pulpy matter. The proportion of kernel to husk and pulp was as follows:

Sample.	Kernel. *Per cent.*	Husk and pulp. *Per cent.*
1.	41	59
2.	37	63

The kernels as extracted from the fruits were of irregular shape, and measured about 1½ in. in length by 1 in. in diameter; they were covered with a thin brown skin, and were white internally. On drying in the air they became brittle, and shrank to a size of about ¾ by ½ in., while the interior became brown.

The three samples of kernels 3, 4, and 5, were examined with the following results:

Number of sample.	Loss on drying in the air.	The air-dried kernels contained:	
		Moisture.	Fat.
	Per cent.	*Per cent.*	*Per cent.*
3.	59	14·5	7·0
4.	74	11·3	12·6
5.	70	13·8	11·4

The fat was solid and of dark brown colour, and had a slight odour.

Previous observers have recorded 32 to 41 per cent. of fat in the kernels of *P. butyracea* (see preceding report on a sample from Southern Nigeria), and even larger amounts have been mentioned (Wehmer, *Die Pflanzenstoffe*, i. p. 497). The highest proportion of fat in the present samples is only 12·6 per cent. in the air-dried kernels, and such kernels would be useless for export to Europe.

These results are recorded as illustrating the necessity of collecting for export only the kernels from fully ripe fruits.

A further small quantity of *P. butyracea* kernels from the Gold Coast was received in February 1913.

The sample consisted principally of large irregular

brownish kernels, a quantity of small shrivelled or immature seeds being also present. The material had not been thoroughly dried, the kernels containing 37·7 per cent. of moisture and only 22·6 per cent. of fat. If thoroughly dried in the sun the kernels would have contained about 10 per cent. of moisture and 31 per cent. of fat. The fat was similar to that extracted from the previous samples.

General Remarks

The results of examination of these *P. butyracea* kernels from the Gold Coast confirm the manufacturer's statement quoted above (p. 570), that the kernels are variable in quality. For export it is desirable that only mature kernels should be collected and that they should be thoroughly dried in the sun before being shipped.

Gru-Gru Nuts and Kernels from the West Indies.

The gru-gru palm, *Acrocomia sclerocarpa*, is native to the West Indies and to South America from Brazil southwards, and is said to form vast forests in Paraguay. The kernels yield an oil also known as "mocaya" oil, and they have been imported into this country from time to time from South America.

Some interest is being taken in these kernels at the present time, and inquiries have been made by the Imperial Institute with a view to ascertaining whether the palm occurs in sufficient abundance in the West Indies to enable the kernels to be exported on a commercial scale. The results of the inquiries showed that the kernels are scarce in Jamaica and there does not appear any possibility of an export trade from that Colony. The palm is widely distributed in Trinidad, but does not commonly occur in such abundance as would render any considerable export trade easy of development; moreover the kernels are in local demand, being roasted and eaten. In Grenada the palm grows freely on poor, rocky hill soils, and might provide material for export without interfering with other crops. The palm exists in some numbers in St. Vincent, but the plants are being destroyed to make way for cotton cultivation, while it occurs in smaller numbers in St. Lucia

and in the Leeward Islands. In connection with this inquiry gru-gru nuts from Grenada and kernels from Trinidad were forwarded to the Imperial Institute for examination.

No. 1. Gru-gru Nuts from Grenada. — These were rounded, brown nuts, slightly flattened at the base and bluntly pointed at the apex. The length from apex to base was ¾ to 1 in., and the diameter was 1 to 1⅛ in. Each nut possessed three "eyes," situated about halfway between the apex and the base.

The shells of the nuts were hard, brittle, and woody; they measured slightly over ⅛ in. in thickness. The kernels, which were of irregular shape, were dark brown externally and white within, and were somewhat similar in appearance to ordinary oil palm kernels (*Elæis guineensis*).

The kernels, which were found to contain 7·3 per cent. of moisture, yielded 56·2 per cent. of a white crystalline fat. This product resembled coconut oil, but it was more opaque and had a less marked odour; it also resembled palm kernel oil.

No. 2. Gru-gru Kernels from Trinidad.—This sample consisted of small, roughly spherical kernels, about ½ to ¾ in. in diameter, with a wrinkled, dark brown exterior. The kernels were in good condition.

They contained 6·1 per cent. of moisture and yielded 57·0 per cent. of a yellowish-white, solid, crystalline fat, similar to that obtained from the kernels from Grenada.

The fats obtained from these two samples were examined with the following results, compared with the corresponding figures for palm kernel oil:

	No. 1.	No. 2.	Palm kernel oil.
Specific gravity at $\frac{100° C.}{15·5° C.}$	0·868	0·867	0·8731
Acid value	1·5	1·3	—
Saponification value	255·1	253·7	242·4 to 254·8
Iodine value . . . *per cent.*	21·0	16·2	10·3 to 17·5
Titer test	20·5° C.	—	20° to 25·5° C.
Hehner value	89·5	88·5	91·1
Insoluble fatty acids . *per cent.*	89·04	88·1	—
Unsaponifiable matter, *per cent.*	0·46	0·4	—
Volatile acids, soluble	6·8	5·7	5·0 to 6·8
„ „ insoluble	10·0	12·6	—

for the first time, is the ideal soil which exists in both these localities for ground-nut production, the heavy yields obtained, and the high quality of the crop (*Nigerian Customs and Trade Gazette*, June 2, 1913). A yield of over 1 ton of freshly harvested nuts per acre was being generally obtained at Kano and at Bida in the 1912–13 season, *i.e.* at least 1,400 lb. of kernels per acre. By selling the latter at $\frac{5}{8}$*d.* per lb., a common price at Kano, a return of £3 12*s.* 11*d.* per acre is obtained, which is said to be quite acceptable to the native producer. The cash price offered for the kernels at Badegi, 43 miles from Baro, in the Niger Province, is £6 per ton, *i.e.* only about the same as the price at Kano, although the kernels have to be carried about 365 miles on the railway from the latter place. If the price paid in the Niger Province could be raised somewhat, it is thought there would be no question that the production would increase greatly. The establishment of a buying depôt at Wuya Kede would be a distinct advantage, as this village is an important ferry situated on the Kaduna river, 35 miles from its confluence with the Niger river, in the centre of a rich and populous district. Large numbers of canoes are available here, and transport can be arranged to Lokoja for as little as 30*s.* per ton.

Another factor tending to check ground-nut production in the Niger and Ilorin Provinces, apart from the inadequate price, is the refusal of trading firms to buy the unshelled nuts. The manual labour involved in shelling a ton of nuts is enormous, as one woman can deal with only about 7 lb. of unshelled nuts per hour. The difficulty could be overcome by the installation of decorticating machines somewhere on the river, say at Egga; but the Director of Agriculture considers that in view of the very much lower price which the native is willing to accept for the unshelled nut the shipping of the nuts in this form is well worthy of attention.

A superior variety of ground nut is grown in limited quantity in the neighbourhood of Pategi, Ilorin Province, and a quantity of this was received for examination at the Imperial Institute in December 1912.

The sample consisted of large, unbroken ground nuts of good appearance. The majority of the nuts were about 1¾ in. long and ⅝ in. in diameter, but a few medium-sized nuts were present, and also some which were 2¼ in. in length. Each nut contained two kernels in good condition. The sample was free from extraneous matter.

The nuts were submitted for valuation to a firm of brokers, who reported that they were much larger and of better quality than the Nigerian ground nuts usually marketed in Liverpool, and valued them at about £19 per ton (March 1913), adding that good prices were then ruling for ground nuts in the United Kingdom.

Gambia

As already mentioned, large quantities of ground nuts are produced in Gambia, the exports during 1912 being 64,169 tons, valued at £502,069. Three samples of ground nuts have been received for examination from this Colony, the first two in February 1910, and the third in January 1911.

No. 1.—"Ordinary Gambia ground nut, Sika." These were somewhat elongated nuts in good condition, consisting of kernel 66 per cent., and shell (husk) 34 per cent. Most of the nuts contained two kernels each, and about 13 per cent. contained three. The kernels yielded 50 per cent. and the whole nuts 33 per cent. of pale yellow, liquid oil.

No. 2.—"Light-skinned ground nuts, Bantankilling. From three or four seeds received from Senegal." The nuts in this sample consisted of kernel 80 per cent., and shell (husk) 20 per cent. They were rounder than the ordinary variety of ground nut. Most of them contained two kernels each, but none were found with three, and about 16 per cent. had only one kernel. A few somewhat mouldy kernels were present in the sample. The kernels had dirty-white or buff-coloured skins. The kernels contained 49·5 per cent., and the whole nuts 39·6 per cent. of pale yellow, liquid oil.

The following table shows the results of chemical

examination of oil extracted from these two varieties of ground nuts:

	Oil from nuts of sample 1.	Oil from nuts of sample 2.	Commercial ground-nut oil.
Specific gravity at $\frac{15\cdot5^\circ C.}{15\cdot5^\circ C.}$	0·928	0·928	0·9195–0·9256
Saponification value	191	190	185·6–197
Iodine value . . . *per cent.*	89	85	83·3–105

From the results of these examinations it appears that the Bantankilling ground nuts furnish a larger proportion of kernels than the ordinary Gambia variety, and therefore give a somewhat larger percentage of oil calculated on the whole nuts. This difference is, however, probably not sufficient to give the Bantankilling variety any considerable advantage over the ordinary kind from a commercial point of view, unless this variety gives a larger yield of nuts, or offers any advantage in cultivation.

No. 3.—These were described as "Fiji ground nuts grown at Kotu, in Gambia." The nuts were large, each containing two kernels. They consisted of kernel 73 per cent., and husk 27 per cent.

The kernels yielded 48·2 per cent. of oil, whilst those of a sample from Fiji previously examined contained 49·1 per cent. (see this BULLETIN 1909, **7**, *272*). The oil had the usual appearance of ground-nut oil, and was not submitted to chemical examination.

The sample was too small for valuation, but ground nuts of similar quality would, when decorticated, probably realise the normal price of good ground-nut kernels, which was then £14 10*s.* to £15 10*s.* per ton in London (March 1911).

There is a demand for unshelled ground nuts of this description, but it is somewhat uncertain, and the price shows considerable fluctuation.

MONTSERRAT

The ground nut is being cultivated experimentally in most of the botanic stations in the West Indies, and eight samples from Montserrat, representing the material produced in the 1911 experiments, were received for examina-

tion in January 1912. The yields of dried nuts per acre obtained in the experiments carried out in 1910 and 1911 were as follows:

Variety.	1910. *lb.*	1911. *lb.*
Carolina Running	1,706	2,438
Carolina Running (small-seeded)	1,548	—
Gambia	1,479	2,041
Gambia (three-seeded)	1,254	2,027
Local Variety	1,670	1,789
Red Tennessee	765	1,846
Virginia Running	—	1,836

The seeds sown in 1911 in the case of the two types of Carolina Running, the two varieties of Gambia, and the Red Tennessee, were the second generation from specially selected plants. The 1911 season was not specially favourable for the crop, as there was a comparative drought during August and September, and its effect on some of the varieties was easily observable; but the Gambia types suffered least.

The results of the experiments showed that although the Carolina Running variety gave the highest yield, the quality of the nuts leaves something to be desired, and the Gambia variety is considered to be the most satisfactory type so far tried in Montserrat.

The samples examined at the Imperial Institute were as follows:

No. 1. "Local."—Rather small nuts, with dirty-looking husks and small kernels with reddish-brown skins. Many of the kernels were shrivelled.

No. 2. "Gambia (three-seeded)." — Fair-sized nuts, which had in most cases clean husks of good colour. The kernels were mostly plump and clean, with pinkish skins; a few, however, were shrivelled. Twenty-two per cent. of the nuts contained three kernels each.

No. 3. "Gambia."—These nuts resembled the preceding variety, but the kernels were darker, and a larger number were shrivelled; none of them contained more than two kernels.

No. 4. "Spanish."—Small nuts of dirty appearance, with very small rounded kernels, which had pale pinkish-brown skins. A good many kernels were shrivelled.

No. 5. "Carolina Running."—Large, rather long nuts, of dirty colour and containing very large kernels, mostly with reddish-brown skins. Some kernels had skins of a dirty brown colour, and a few were shrivelled.

No. 6. "Carolina Running (small-seeded)."—Fair-sized nuts of rather dirty colour, with kernels of medium size, having skins varying in tint from reddish-brown to dirty brown. A few kernels were shrivelled.

No. 7. "Virginia Running."—Large nuts of good appearance, in most cases having clean-looking husks and somewhat long, plump kernels with rather dark red skins. Some shrivelled kernels were present.

No. 8. "Red Tennessee."—Very long, large nuts, of fairly good appearance, with very dark reddish-brown kernels of fair size; a considerable number of the kernels were shrivelled. Nearly half the nuts contained three kernels. The kernels had a rather unpleasant taste.

The following table shows the average weight of the single nuts in each sample, the percentage of husk and kernel, and the percentage of nuts containing one, two, three, or no kernels:

Sample No.	1.	2.	3.	4.	5.	6.	7.	8.
Average weight of a single nut . . *grams*	0·87	1·20	1·14	0·65	1·62	1·36	1·97	1·96
Percentage of husk . .	30	30	33	24	30	26	30	36
Percentage of kernel .	70	70	67	76	70	74	70	64
Percentage of nuts containing:								
1 kernel . . .	13	10	16	35	22	17	9	20
2 kernels . . .	83	60	84	61	76	80	91	29
3 kernels . . .	*nil*	22	*nil*	*nil*	*nil*	*nil*	*nil*	49
No kernel . . .	4	8	*nil*	4	2	3	*nil*	2

The nuts were submitted for valuation to (1) a firm of brokers in Liverpool, (2) a firm of oil seed crushers in Marseilles, and (3) a firm of merchants in Hamburg. The three firms reported on the samples as follows:

(1) The samples are all of inferior colour, and of a quality rarely marketed in Liverpool. They are not fine enough for sale to English fruit merchants or confectioners, and would be more likely to find a market among Continental oil seed crushers. Their values in Liverpool, ex

quay, in bags, would probably be approximately as follows (May 1912):

No.	Name.	Price per cwt.
1	Local	10*s.*
2	Gambia (three-seeded)	10*s.*
3	Gambia	12*s.*
4	Spanish	9*s.*
5	Carolina Running	11*s.*
6	Carolina Running (small-seeded)	10*s.*
7	Virginia Running	12*s.* 6*d.*
8	Red Tennessee	12*s.*

(2) These ground nuts should realise in Marseilles prices similar to those obtained for "Gambia" nuts, the current value of which is 35 fr. per 100 kilos (14*s.* 2*d.* per cwt.) c.i.f. Marseilles (April 1912).

(3) The value of the samples for edible purposes, c.i.f. European ports, should be as follows, with Rufisque ground nuts at 36 fr. per 100 kilos (14*s.* 7*d.* per cwt.):

Nos. 1, 2, 3, and 6.	About 34 fr. per 100 kilos.	13*s.* 10*d.* per cwt.
No. 4	" 32 " " "	13*s.* "
Nos. 5, 7, and 8	" 30 " " "	12*s.* 2*d.* "

It may be pointed out in connection with these valuations that the current price of undecorticated Coromandel ground nuts in the United Kingdom at the time of the report was 13*s.* to 14*s.* per cwt. (May 1912). Rufisque ground nuts suitable for edible use are more valuable, and good samples are worth about 17*s.* per cwt. (April 1912).

It is clear from the foregoing results that these ground nuts would be saleable in Europe. The large supplies of ground nuts imported to the Continent are mainly used for the preparation of edible oil, whilst the small quantities of unshelled nuts imported to the United Kingdom are used as edible nuts. For the latter purpose it is desirable that the husks should be clean and of good colour, and special attention would have to be given to these points where it is proposed to export ground nuts to the United Kingdom.

Fiji

Ground nuts are only cultivated on a very small scale in Fiji at present, the export in 1911 being 3 tons 7 cwts., valued at about £51.

The sample referred to below was received for examination in July 1909. It was labelled "Spanish Pea Nuts," and consisted of unshelled nuts, described as representing the 1909 crop grown at the experimental station at Lautoka.

The nuts were mostly in very good condition, but a few were slightly damaged or discoloured. They were large, varying in length from 1¼ to 2 in., with an average of about 1⅜ in. Most of the nuts contained two kernels, but there were a few containing only one. The kernels extracted from the nuts were in good condition, very few being shrivelled or discoloured. They were of normal size, colour, and appearance, and formed about 70 per cent. by weight of the unshelled nuts.

The sample of Fiji ground nuts previously examined at the Imperial Institute was found to give an average yield of oil, and as the present sample was quite similar no further analysis was made.

The best market for ground nuts is Marseilles, and for that reason samples of these Fiji nuts, previously shelled, were submitted to a firm in that port for valuation. They reported that the kernels would sell in Marseilles at about the same rate as Coromandel kernels, viz. 30 fr. per 100 kilos (about £12 per ton) in December 1909.

Samples of the shelled nuts were also supplied to brokers in Liverpool, who stated that they would be worth about as much as Chinese kernels, viz. £13 10*s.* to £14 per ton, c.i.f. (December 1909).

Ground-nut Oil from Fiji

A sample of ground-nut oil stated to have been expressed from large Spanish ground nuts in the cold, was received in April 1913. It consisted of golden yellow oil, faintly opalescent, but otherwise of the usual appearance of ground-nut oil.

The constants of the oil were as follows:

Specific gravity at $\frac{15.5° C.}{15.5° C.}$		0·919
Acid value		2·4
Saponification value		193·2
Iodine value	*per cent.*	89·4

This oil is evidently of good quality, the acid value being comparatively low, and it would probably be worth about £30 a ton in the United Kingdom. If better prepared, however, of a paler tint, and cleared so as to remove the opalescent appearance, it should realise £37 or more per ton as an edible oil (September 1913).

BAOBAB FRUITS AND SEEDS FROM THE EAST AFRICA PROTECTORATE

THE baobab tree (*Adansonia digitata*, L., natural order, Malvaceæ) is a large tree common in many parts of Africa and growing also in India and other tropical countries. The inner bark is very fibrous and is used by the natives of West Africa for the manufacture of rope and sacking, and it was at one time imported to this country for paper-making. A sample of the bark from Rhodesia, and one of fibre prepared from the bark in the East Africa Protectorate, have been examined at the Imperial Institute (this BULLETIN, 1904, **2**, 169; 1907, **5**, 234). The leaves and the acid pulp which surrounds the seeds are used in native medicine in West Africa, and the results of examination of specimens of these two products from Sierra Leone, stated to be derived from *A. digitata*, have been described in this BULLETIN (1906, **4**, 252).

The seeds of some species of Adansonia, *e.g.* *A. madagascariensis*, Baill., and *A. Grandidieri*, Baill., contain a considerable quantity of oil and have appeared on the oil seed market in Marseilles. In order to ascertain whether the baobab seeds of East Africa were likely to be of commercial value in this direction, a supply of the seeds and fruits was obtained from the East Africa Protectorate for examination at the Imperial Institute. The Director of Agriculture stated that it is estimated that there are approximately 30,000 baobab trees in the Protectorate, each of which yields annually on an average 30 lb. of dry seed, in all over 400 tons per annum. The acid pulp surrounding the seeds, after being soaked in water and with the addition of a little common salt or sea-water, yields an extract which forms the

chief agent used in East Africa for coagulating the latex of the Ceara rubber tree, and it is thought that a considerable quantity of seed would be available as a by-product at the rubber plantations.

The results of examination of the seeds and fruits have been communicated to the Society of Chemical Industry in a paper by Mr. R. G. Pelly, F.I.C., of the Scientific and Technical Department of the Imperial Institute (*Journ. Soc. Chem. Indust.* 1913, **32**, 778). These results may be summarised as follows:

Each fruit weighed about 1 lb., and consisted of a hard, brittle, woody shell, about 11 in. long and 4 in. in diameter, and bluntly pointed at the ends. The interior was divided into nine compartments by fibrous septa; each compartment contained a mass of dry buff-coloured friable pulp surrounding and adhering to the numerous small kidney-shaped seeds. The fruits were composed of outer shell 41–48 per cent., pulp 14–17 per cent., seeds 36–42 per cent.

The outer woody shell yielded 2·4 per cent. of ash, containing: silica, 2·8 per cent.; potash, 47·0 per cent.; soda, 1·5 per cent.; phosphoric anhydride, 0·3 per cent.

The seeds were composed of a very tough husk enclosing a soft oily kernel, devoid of starch. They were examined with the following results: [1]

	Per cent.
Moisture	12·1
Ash	3·5
Oil	11·6
Proteins	11·2
Fibre	22·5
Carbohydrates (*by difference*)	39·1

The ash of the seeds contained: potash, 31·0 per cent.; soda, 7·2 per cent.; phosphoric anhydride, 34·2 per cent.

The oil as extracted by light petroleum was viscous, clear, and bright yellow, with no marked taste or odour; it gave the following results, to which are added, for purposes of comparison, the results obtained by previous observers

[1] Owing to the tough nature of the husk it was extremely difficult to grind the seeds and mix the material thoroughly; the analytical results are, therefore, only approximately accurate.

for oil from seeds of *A. digitata* and fat from seeds of *A. Grandidieri.*

	Oil from baobab seeds from East Africa.	Oil from seeds of *A. digitata.*	Fat from seeds of *A. Grandidieri.*
Yield of oil . *per cent.*	11·6	12·5	42·6
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$.	0·920	0·915	0·918
Saponification value . .	193·5	190·5–191·7	189·9–190·9
Iodine value . *per cent.*	82·0	76·7– 77·8	53·9– 56·8

From the above figures it is obvious that the British East African seeds contain too small an amount of oil to render them of commercial value as a source of oil.

The seeds are free from alkaloids and cyanogenetic glucosides, but the husks are so tough that the seeds would require boiling to soften them before they could be employed as cattle food. The seeds, or the ash from them, which is rich in potash and phosphates, could be used as manure.

Fruit. Pulp.—Specimens of the fruit pulp of species of *Adansonia* have been investigated previously. Slocum (*Pharm. Journ.* 1879–80, **10**, series 3, 816) stated that the pulp of *Adansonia* sp. (probably *A. digitata*) contained pectin, glucose, malic acid, and acid potassium malate, etc.; Heckel and Schlagdenhauffen (*Pharm. Journ.* 1888–89, **19**, series 3, 246) recorded the presence of tartaric acid (2 per cent.) and potassium hydrogen tartrate (12 per cent.), etc.; Millard (*Pharm. Journ.* 1889-90, **20**, series 3, 829) stated that traces of tartaric acid and 10 per cent. of potassium hydrogen malate were present in the pulp of a species of *Adansonia*, probably *A. madagascariensis.* The pulp of *A. digitata* from Sierra Leone previously examined at the Imperial Institute (this BULLETIN, 1906, **4**, 252) was found to contain free tartaric acid and potassium acid tartrate, as well as a large quantity of mucilaginous matter.

In the case of the present sample from the East Africa Protectorate specimens of pulp taken from different fruits yielded the following results:

	Per cent.
Moisture	15–16
Ash	4·76– 6·10
Matter soluble in alcohol . . .	16·7 –18·7

The ash consisted largely of alkaline carbonates and contained: silica, 4·74 per cent.; lime, 8·88 per cent.; potash, 48·90 per cent.; soda, 4·20 per cent.; phosphoric anhydride, 1·08 per cent.

The greater part of the pulp was soluble in water, yielding a mucilaginous liquid and an insoluble residue of cellular tissue. The aqueous extract possessed an acid taste and reaction. The pulp consisted largely of pectous matter, and considerable difficulty was experienced in separating the crystalline acids from this matter. The method finally adopted is described in full in Mr. Pelly's paper. It was found that the acidity of the pulp is due partly to free citric acid, with possibly a small amount of malic acid, but chiefly to an acid or acids of the pectic type, possibly present as acid potassium salts. The amount of citric acid in the pulp was not more than 4·4 per cent. No indications of the presence of tartaric acid were obtained, and it was proved that such acids as tartaric, malic, or citric acids are not present as acid salts in the fruit pulp.

Commercial Value of the Seeds and Fruits

The seeds would not realise a sufficiently high price in Europe as an oil seed to make their exportation remunerative, but they might be used locally in East Africa as a cattle food, if it is feasible to soften the husks by boiling the seeds in water. The finely-ground seeds, or the ash from them, which is rich in potash and phosphates, could be employed locally as a manure.

The shell of the fruit might be used locally as fuel, and the ash of the shell employed as a potash manure.

Although the fruit pulp contains a fair amount of free citric acid, this could not be extracted remuneratively, owing to the large amount of pectous matter present, which renders the extraction of the citric acid extremely difficult. It is highly improbable that the pulp would be of any commercial value, except locally in East Africa as a rubber coagulant, or for the preparation of pleasantly acid drinks, for which purpose it is already largely used in the tropics.

TOBACCOS FROM THE EAST AFRICA PROTECTORATE

CONSIDERABLE attention has been devoted in recent years to the cultivation of tobacco in various parts of British Africa, and at the present time the crop is being grown successfully in Nyasaland, Rhodesia, Transvaal, and Cape Province (see this BULLETIN, 1906, **4**, 384; 1909, **7**, 27; 1911, **9**, 384, 416; 1913, **11**, 320). Among African tobaccos which have been described already in this BULLETIN may be mentioned those from Nyasaland (1904, **2**, 80; 1909, **7**, 266), Transvaal (1909, **7**, 404), Cape Province (1913, **11**, 320), and Portuguese East Africa (1913, **11**, 11).

Although a coarse type of tobacco has been grown by the natives of the East Africa Protectorate for their own use for many years, it is only within the last few years that attempts have been made to grow leaf suitable for export to Europe. A number of planters have taken up its cultivation experimentally, and trials have also been made at the Government Experimental Farms at Mazeras and Kibos, but the earlier work was handicapped to a certain extent by the lack of expert advice. In 1911, however, an Adviser for Tobacco was appointed by the Government, and experiments have been commenced under his supervision at the Kabete Experimental Farm (see p. 593). A small supply of seed of American and Turkish tobaccos was obtained, and the greater part of this seed was distributed to over thirty planters, who expressed a desire to experiment with the crop, but the results of these trials are not yet available. Arrangements were made for sets of flue-pipes for tobacco-curing barns to be distributed among those planters who contemplated growing "bright American" tobaccos, one set being supplied to a planter in each of the following districts: Kikuyu, Fort Hall, Nakuro, Njoro, Lumbwa, and Uasin Gishu.

In a report furnished to the Imperial Institute the Adviser for Tobacco states that the Kibwezi district, where an extensive irrigation scheme is being introduced, will probably prove one of the most suitable in the Protectorate for the crop. Other districts which apparently have soils

suited to "bright" tobacco are in the Mua Hills, near the Lower Molo river, and near part of the Sergoit river on the Uasin Gishu plateau.

Soils from Kibwezi have been examined by the Government Analyst, with the following results:

No. 1. Top soil.

No. 2. Soil taken out of a 2 ft. pit.

No. 3. Ditto.

No. 4. Top soil.

No. 5. Soil taken out of a 2 ft. pit.

Results of Chemical Analyses

No.	Moisture.	Organic matter.	Nitrogen.	Chalk.	Available phosphoric acid.	Available potash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	2·50	9·53	0·238	0·028	0·0412	0·0805
2	4·05	8·37	0·109	0·004	0·0164	0·0471
3	3·49	9·79	0·092	0·008	0·0079	0·0483
4	2·43	9·96	0·227	0·070	0·0330	0·0331
5	4·07	9·69	0·081	0·009	0·0235	0·0408

Results of Mechanical Analyses

	No. 1. *Per cent.*	No. 4. *Per cent.*
Fine gravel	*nil*	*nil*
Coarse sand	31·8	24·3
Fine sand	33·7	34·9
Silt	5·0	7·6
Fine silt	12·9	16·3
Clay	4·5	4·5
Moisture	2·50	2·43
Organic matter	9·53	9·96
Chalk	0·03	0·07

The following results of chemical analyses of soils from Kabete are quoted by the Adviser for Tobacco in his report:

No. 1. Top soil, 9 in.
No. 2. Subsoil, 9 „
No. 3. Top soil, 9 „
No. 4. Subsoil, 9 in.
No. 5. Top soil, 9 „
No. 6. Subsoil, 9 „

No.	Moisture.	Organic matter.	Nitrogen.	Chalk.	Available phosphoric acid.	Available potash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	7·42	18·69	0·459	0·082	0·021	0·039
2	7·23	15·68	0·269	0·088	0·041	0·030
3	7·51	16·40	0·330	0·081	0·028	0·027
4	7·69	14·75	0·271	0·054	0·064	0·015
5	7·41	18·49	0·454	0·092	0·0382	0·011
6	7·48	14·62	0·258	0·054	0·0382	0·015

A number of soils from the East Africa Protectorate have also been examined at the Imperial Institute, and the results of examination of some of these are given in this BULLETIN (1907, **5**, 243; 1912, **10**, 405).

Experiments with several varieties of American and Turkish tobaccos were conducted at Kabete during 1912, and samples of the tobacco produced were forwarded to the Imperial Institute for examination. Tobaccos grown on private estates in earlier years have also been received. The results of the investigation of these tobaccos are given in the following pages.

First Series

The samples of tobacco which are the subject of this report were forwarded to the Imperial Institute in August 1909. They were stated to have been grown at Nairobi.

No. 1.—This consisted of three hands of "Virginian" tobacco of light "mahogany" colour, nearly free from spots and blemishes. The leaves measured, on the average, 16 in. by 8½ in.

The tobacco burnt well, leaving a pale grey ash edged with black. The aroma of the smoke was pleasant, but slightly pungent.

No. 2.—This was a small hand of light "mahogany" tobacco, in good condition. The average size of the leaves was 11 in. by 5 in., with a few larger leaves measuring 13 in. by 6½ in.

The tobacco held fire fairly well, and left a pale grey ash edged with dark grey.

No. 3.—This consisted of two hands of "Virginian" tobacco, light "mahogany" in colour, and of good appearance. The leaves varied in size from 14½ in. by 7½ in. to 17 in. by 8¾ in.

The tobacco burnt fairly well, leaving a dark grey ash. The aroma of the smoke was fairly pleasant.

No. 4.—This was a single hand of "mahogany"-coloured leaves which were in good condition, although a few showed green, unfermented spots close to the edges and midribs. The average size of the leaves was 14 in. by 8½ in.

The tobacco held fire fairly well, but unevenly, some patches burning rapidly, others merely charring. The ash was dark and carbonaceous.

No. 5.—A single hand of rather small leaves. The colour was light "mahogany," and the general appearance was good. The leaves measured on the average 10½ in. by 5½ in., while a few were 13 in. by 7 in.

The sample held fire moderately well, but unevenly, and left a very dark ash. The aroma of the smoke was rather pungent.

Samples Nos. 1 and 3 were analysed with the following results:

		No. 1. *Per cent.*	No. 3. *Per cent.*
Moisture		11·37	13·64
Total alkaloids (nicotine, etc.)		3·20	3·82
Total nitrogen		1·99	1·82
Ash		15·46	13·68
The ash contained:			
Lime	CaO	41·9	36·3
Magnesia	MgO	11·7	12·1
Potash	K_2O	21·6	19·1
Sulphuric anhydride	SO_3	3·7	3·7
Chlorine	Cl	0·4	1·3

The samples were of fairly satisfactory composition, but the ash contained somewhat high percentages of magnesia and sulphuric anhydride for the amount of potash present. More chlorine was present in the ash of No. 3 than in No. 1, and the percentage of potash was slightly lower in this sample, and these differences will account for the slightly darker colour of the ash (see p. 589).

Samples 1, 3, 4, and 5 were submitted to commercial experts, who reported that Nos. 1 and 3 were of nice appearance and burnt freely, but were not pleasant to smoke, whilst Nos. 4 and 5 lacked body and quality.

It was stated that the only real test of value would be to place the tobacco on the market, but it was considered that tobacco similar to the samples might be saleable at 3½*d.* per lb. or more (duty-free), for blending with other tobaccos requiring colour without strength.

These five samples of tobacco were of promising quality. The best is No. 1, which corresponds most closely to "Virginian" tobacco as imported to this country from the

United States, but there is on the whole little to choose between the samples except as regards the size and texture of the leaves.

The chief defects of these tobaccos, and the methods by which they can be minimised, may be summarised as follows:

(1) Some of the samples produced a smoke of slightly pungent flavour, and most of them left a dark-coloured ash.

Both these defects are probably due to the presence of too high a proportion of chlorides and sulphates compared with the potash in the ash. In manuring soil on which tobacco is grown, manures containing sulphates or chlorides should be avoided. The best manures are usually plant ashes rich in potassium carbonate, and they should be applied to the ground some months before the seedlings are planted out.

(2) Some of these samples, notably Nos. 4 and 5, consisted of small leaves, and all except No. 1 were composed of leaves which were too thin.

These defects are probably caused by the plants being grown too close together, or in poor soil. For this type of tobacco the plants should be placed at a distance of about 3 ft. from each other, and in rows 3½ ft. apart. The actual space allowed must, however, in all cases depend to some extent on the richness of the soil.

It is probable that in the present instance the soil in which the tobacco was grown would give a better product if it were green-manured.

(3) The size of the leaves included in some of the hands of tobacco varied considerably. This is an important matter in grading tobacco for export. The hands should consist of leaves not only of the same colour, but also of approximately the same size, and all hands containing leaves of a certain size should be kept together.

(4) The tobacco of the present samples was all of the "mahogany" type, that is, it was yellow, evenly marked with reddish-brown patches. It should, however, be borne in mind that the best prices are paid for "bright" and "semi-bright" Virginian tobacco, that is, for kinds which are of

uniform bright yellow or semi-bright yellow colour. Thus, at the date of the report, "ordinary" to "fine" "bright" tobaccos of this class were worth 6*d.* to 1*s.* per lb., whereas "ordinary" to "fine" "dark" tobaccos fetched from 6½*d.* to 8*d.* per lb. (December 1909).

Second Series

The following three samples of tobacco were grown at Njoro, and were received in August 1911:

No. 1.—Described as "grown from seed received from the Transvaal, and sun-dried on the stem."

This consisted of rather coarse leaves, varying from 12 to 20 in. in length, and from 5 to 8 in. in width. The colour was not uniform throughout the sample, and was patchy; the majority of the leaves were dull brownish-yellow, and the others of a lighter and brighter tint, except a few leaves which were marked with greenish patches.

No. 2.—"American tobacco dried in the shade."

This sample consisted of rather coarse leaves, of uniform shape and measuring from 16½ by 5½ in. to 20½ by 7½ in., being mostly of the larger sizes. The colour varied from dull "mahogany" to a lighter tint with a tinge of green. The leaves were slightly mouldy.

No. 3.—"American tobacco dried in the sun."

This consisted of rather coarse leaves varying in size from 13 by 4 in. to 20 by 7 in., but mostly of medium dimensions. The colour varied from bright to dull "mahogany," and a fair number of leaves had a distinct greenish tinge.

Sample No. 1 burnt fairly well and left a greyish ash. It gave the following results on analysis:

		Per cent.
Moisture		12·33
Total alkaloids (nicotine, etc.)		3·07
Total nitrogen		3·31
Ash		13·88
The ash contained:		
Lime	CaO	26·38
Magnesia	MgO	7·30
Potash	K_2O	32·80
Sulphuric anhydride	SO_3	3·75
Chlorine	Cl	2·63

The above figures show that the tobacco was of satisfactory composition. The sample was not, however, prepared in such a way as to meet the requirements of British manufacturers, and in these circumstances it was not submitted for valuation, since any value placed on the tobacco in this condition would not represent the price it should realise if properly cured.

Samples 2 and 3 consisted of pipe tobacco cured by the methods applicable to cigar tobacco, and they do not conform to any type of tobacco used in the United Kingdom. They were not examined chemically.

None of these three tobaccos represents a type largely used by manufacturers in the United Kingdom, and they could only be sold at low prices as nondescript manufacturing tobaccos. The examination of sample No. 1, however, indicated clearly that if properly grown and cured, the tobacco would be readily saleable in the United Kingdom. The ash is rich in potash, so that no difficulty need be anticipated in producing tobacco of good burning quality on the soil on which the sample was grown.

Third Series

Seven samples of tobacco grown experimentally at Kabete, under the supervision of the Adviser for Tobacco, were received in December 1912. The following particulars regarding the experiment were supplied.

The American varieties tried were Hester, Goldfinder, Yellow Oronoco, Ragland's Improved Yellow Oronoco, and Stirling. The following Levantine varieties were also sown. Smyrna, via Rhodesia, Turkish seed from the United States, and Cavalla and Ayasalouk, the last two being supplied by the Imperial Institute.

The seed was sown February 1 to March 8, 1912, and planting out was started on April 8 and continued to May 25. In spite of the fact that the plantation was treated with a mixture of "Paris Green" and bran, "cutworm" did considerable damage, some plots having to be replanted five times.

The American varieties were planted 3 ft. by 3 ft.,

whilst the Turkish varieties were planted 6 to 8 in. apart, with 2 ft. between the rows.

The young plants were kept well cultivated and were sprayed from time to time with insecticides and fungicides.

This kept insect pests and fungoid diseases in check for some time, but the rainfall was greater than usual, followed by several months of cloudy weather, with the result that the plants became attacked with white mildew, which destroyed a large quantity of the crop. This was especially bad amongst the Turkish tobacco.

Most of the American tobacco grew well in the field, but the leaf was of a very dark green colour. The "Goldfinder" was rather large and coarse. The same remarks apply to the Turkish tobacco, of which the "Cavalla" variety had the best appearance.

Reaping of the Turkish leaf was begun on June 11, and continued to October 11, but throughout this period there was little sunshine, and the leaf remained to a large extent green, whilst the amount of moisture in the air caused the exposed part of the leaf to darken considerably.

The first reaping of American tobacco was made on June 28, and the last on September 30. The greater part of this leaf was cured in the flue-barn, but, though many methods were tried, it was found impossible to get the leaf to cure a good colour, the green always predominating. The Adviser for Tobacco, therefore, considers that tobacco grown on the red soil of Kabete would give better results if "air-cured."

The samples examined at the Imperial Institute were as follows:

No. 1. "*Sterling Bright.*"—The leaves varied in size from 16 by 6 in. to 20 by 10 in., and were mostly of a dull orange-brown colour, with greenish patches. They were fairly uniform in colour and size, moderately tough, and of fine texture.

The tobacco burnt moderately well, leaving a grey, flocculent ash. The smoke was of rather strong flavour and the aroma somewhat pungent.

No. 2. "*Ragland's Improved Oronoco.*"—The leaves

varied in size from 17 by 7 in. to 25 by 9 in., and were mostly of a dull yellowish-green colour, though a few were brown with a greenish tinge. They were of moderate thickness, and fairly tough: some leaves showed green patches.

The tobacco burnt fairly well, leaving a dull grey ash with white edges. The smoke was mild in flavour and aroma, but not very pleasant.

No. 3. "*Hester.*"—The leaves were fairly uniform in size, the smallest being 20 by 9 in. and the largest 25 by 9 in. They were coarse in texture, fairly tough, and were mostly of dull brown colour. A few "burns" were noticed in some cases, but the majority of the leaves appeared to be free from such defects.

The tobacco burnt fairly well, leaving a nearly white ash. The flavour and aroma of the smoke were mild, but not very pleasant.

No. 4. "*Ayasalouk.*"—The leaves were irregular in size, varying from 4½ by 2 in. to 12 by 5 in., the average being about 8 by 3½ in. The leaves varied in colour from dull greenish-yellow to a dull brown, and were moderately fine in texture but fairly tough. The aroma of the tobacco was poor.

This tobacco burnt fairly well, leaving a pale grey ash. The flavour and aroma of the smoke were mild, but only slightly reminiscent of Levantine tobacco.

No. 5. "*Cavalla.*"—The leaves varied in size from 4 by 1⅓ in. to 12 by 4 in., with an average of about 9 by 3½ in. In general the sample was of dull brown colour, but it was not very uniform in this respect. The leaves were of fine texture and fairly tough. They were a little more aromatic than those of sample No. 4.

The tobacco burnt fairly well, leaving a nearly white ash. The flavour and aroma of the smoke were rather pungent, and only slightly reminiscent of Levantine tobacco.

No. 6. "*Turkish, from Smyrna seed.*"—The leaves were fairly uniform in size, the smallest measuring 8 by 3 in., and the largest 12 by 5 in., with an average of about 10 by 4 in. They were mostly of dull brown colour, of fine texture and fairly tough.

The tobacco burnt well, leaving a grey ash. The smoke had a rather pungent flavour and aroma, only slightly reminiscent of Levantine tobacco.

No. 7. "Turkish, from seed obtained from United States."—The leaves varied in size from 6 by 2½ in. to 13 by 5½ in., with an average of about 9 by 3½ in., and were mostly of dull brown colour. They were fine in texture and fairly tough.

The tobacco burnt moderately well, leaving a nearly white ash. The flavour and aroma of the smoke resembled those of sample No. 6.

Samples 2, 3, 5, and 6 were submitted to chemical examination, the results of which are given in the tables on pp. 597, 599.

Commercial Valuation

The samples were submitted to three firms of manufacturers, who furnished the following reports:

(1) The first firm, after testing the samples, valued them in London as follows (March 1913):

Sample.	Variety.	Value per lb.
1.	Sterling Bright	about 6*d.*
2.	Ragland's Improved	about 4*d.*
3.	Hester	about 5*d.*
4.	Ayasalouk	about 5*d.* to 6*d.*
5.	Cavalla	
6.	Turkish, from Smyrna seed	
7.	Turkish, from seed obtained from the United States	

The firm added that samples 4 to 7 had very little flavour or character, and were too dark and not sufficiently aromatic to be satisfactory for cigarette purposes.

(2) A second firm considered samples 1, 2, and 3 to represent products which could only be used sparingly in the cheapest pipe tobaccos, and which would have to be sold at a lower rate than Virginia or Kentucky tobacco in order to find a market.

(3) Samples 4 to 7 were submitted to a third firm, who were of opinion that these tobaccos might perhaps be used for blending purposes, and considered that the inferior aroma of the samples was probably partly due to imperfect fermentation.

Remarks and Recommendations

"Virginian" tobaccos.—For convenience of discussion the analytical results obtained with Nos. 2 and 3 of these tobaccos are summarised in the following table in comparison with the results of the examination at the Imperial Institute of Nyasaland tobaccos of the same type.

	East African tobaccos.		Nyasaland tobaccos.		
	No. 2.	No. 3.	No. 1.	No. 2.	No 3.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	5·02	4·92	9·9	8·9	8·8
Total alkaloids (nicotine, etc.)	3·20	5·15	1·2	2·2	1·5
Total nitrogen	3·84	4·46	1·3	2·2	1·5
Ash	22·67	17·21	14·4	8·1	8·7
Composition of ash:					
Lime CaO	33·20	33·56	17·4	36·3	26·8
Magnesia MgO	7·11	9·95	5·7	9·3	8·8
Potash K_2O	22·43	22·30	30·0	22·8	32·6
Sulphates, expressed as sulphuric acid SO_3	4·17	5·01	1·9	3·7	2·2
Chlorides, expressed as chlorine Cl	0·66	0·90	0·4	2·2	0·3

It should be pointed out in the first place that the chemistry of tobacco is not yet so well developed that the results of analysis of a sample of tobacco can be regarded as an infallible guide in forming an opinion of its quality, and such results must still be supplemented by subjective tests made by experts having a knowledge of the requirements of the tobacco market. Such tests are, however, incomplete from the point of view of the producer of raw materials, since being subjective they are, so far as new tobaccos are concerned, little more than expressions of opinion reflecting the particular tastes of the experts who make the tests. The results of both these methods of examination are therefore given in this report.

The table given above shows that these East African tobaccos contained unusually small amounts of moisture when received, that is, they were packed too dry. This, however, is a matter of small importance at the present moment, since it will be easy to pack the tobacco in such a state that it will reach this country containing from 10 to 12 per cent. of moisture, which is sufficient to keep the leaves in good condition for handling.

Much more important are the amounts of nitrogen and nicotine, which are higher than those found in the Nyasaland tobaccos, though they are not outside the range that has been recorded for Virginian tobaccos. The quantities of ash are also higher than those in the Nyasaland tobaccos, though again they are not outside the recorded range for Virginian tobaccos. The composition of the ash is fairly satisfactory, though on the whole there is less of the desirable constituent potash, and more of the undesirable components, sulphates and chlorides, than in the Nyasaland tobaccos with which the present samples are compared.

The Adviser for Tobacco makes it clear in the letter forwarded with these samples that the season in which these tobaccos were grown was unfavourable, and he was also apparently of opinion that the soil on which they were grown was not quite suitable for this kind of tobacco. The results of examination of these samples support the view that the soil at Kabete is unsuitable for this kind of tobacco, though they are not quite conclusive on this point, because the unfavourable climatic conditions would also tend to modify the composition of the tobacco in the same direction as the soil, supposing, as seems to be the case, that the latter is too rich in nitrogen and rather rich in lime.

It was recommended that in the next season the experiments should be continued with Virginian tobacco at Kabete, with the following objects:

(1) To produce a dark air-cured "Virginian" leaf.

(2) To try the production of "bright Virginian" leaf on Kabete soil which has borne two or three crops of maize or other cereal.

(3) To produce "bright Virginian" leaf on the plots which furnished the tobaccos now under report.

At the same time a plot of cigar tobacco should be tried at Kabete.

Trials with "Virginian" tobacco should also be made elsewhere in the Protectorate, on a soil obviously better suited to "bright Virginian" tobacco than that at Kabete. The soils of the Kibwezi district, judging from the analyses

quoted by the Adviser for Tobacco (see p. 588), should be suitable for such a trial.

Levantine Tobaccos—The results of examination of two of the four samples (Nos. 4 to 7) of Levantine tobaccos submitted are summarised in the following table, in comparison with those of commercial Levantine tobaccos.

	East African samples. Levantine types.		Commercial samples of Levantine tobaccos.		
	No. 5.	No. 6.	Macedonian.	Greek.	Samos.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	7·20	6·92	9·4 to 10·9	8·9 to 10·6	9·9
Total alkaloids (nicotine, etc.)	0·88	0·82	0·91 to 2·90	2·2 to 3·1	0·79 to 1·6
Total nitrogen	3·72	3·71	2·00 to 2·50	3·1 to 4·4	1·6 to 2·2
Ash	15·83	13·71	9·30 to 13·20	11·8 to 15·3	10·6 to 14·8
Composition of ash :					
Lime CaO	31·42	24·28	39·12 to 58·8	30·7 to 45·7	40·0 to 44·2
Magnesia MgO	10·35	8·81	5·34 to 7·9	1·7 to 10·9	4·5 to 13·3
Potash K_2O	22·24	25·97	6·87 to 12·67	7·4 to 20·6	7·3 to 13·2
Sulphates, expressed as sulphuric acid SO_3	5·90	5·82	2·57 to 4·25	2·5 to 4·5	4·1 to 9·0
Chlorides, expressed as chlorine Cl	1·27	0·97	traces to 1·38	0·29 to 1·9	traces to 3·38

These "Levantine" tobaccos from East Africa have defects of the same type as those noted in the case of the "Virginian" tobaccos, defects which are probably due to the cultivation of the tobaccos on a soil too rich for these types, but which may also be in part due to the unfavourable season.

The experiments with Levantine types of tobacco should, however, be continued on the lines suggested on p. 598 for further experiments with "Virginian" tobaccos.

General Conclusions

The results of the examination of these seven samples of tobacco indicate that the tobaccos have been grown under conditions which have induced too rank a growth. These conditions are probably over-richness of soil and excess of moisture in the atmosphere. Some of the effects of these unfavourable conditions have been reduced by the process of curing, but owing, no doubt, to the very unfavourable climatic conditions of the 1912 season, the improvement thus induced is not sufficient to make the

tobaccos of good commercial quality. The tobaccos are, however, quite as good as could be expected in a first experiment, and the results of their examination afford reasonable ground for the belief that when a type of tobacco suitable to the soil has been found it will be possible to grow tobacco of excellent quality in East Africa in normal seasons. The further experiments suggested on pp. 598 and 599 should afford assistance in this direction.

In view of the importance of finding a tobacco suitable for cultivation on the soil represented at Kabete, it is very desirable that cigar types of tobacco should be tried there.

COTTON GROWING IN THE GOLD COAST

Cotton has been grown on a small scale in the Gold Coast for many years for the manufacture of native cloths, but comparatively little has been exported. The variety grown by the natives is a perennial type and of very mixed nature. Attempts have been made by the Local Department of Agriculture and by the British Cotton Growing Association to encourage the natives to extend the cultivation, but so far with little success, owing to the fact that more lucrative crops, such as cocoa, can be grown, while the collection of oil palm products gives them a larger return with less labour.

In 1903 a Cotton Expert was appointed and large quantities of seed of American varieties were distributed to the natives, and small experimental areas, under the supervision of native chiefs, were established in a few selected districts. A cotton farm was established at Labolabo, in the Eastern Province, near the Volta river, and the early experiments, especially with American varieties, gave promising results. Improved American Upland cottons, including "Black Rattler," "Richmond," and "Georgia," gave yields of seed-cotton ranging from 450 to 730 lb. per acre, with an average of 501 lb.; four strains of native cotton gave an average yield of 369 lb., but "Mitafifi" cotton yielded only 215 lb. per acre. In 1906

the entire supervision and management of the development of cotton cultivation in the Gold Coast was undertaken by the British Cotton Growing Association, who took over the experimental plantation at Labolabo and erected a steam ginnery with three saw gins there, the Government having decided to assist only with monetary grants. The progress in this district, however, was slow, and in 1909 the Association gave up the experimental work at Labolabo, but continued to maintain the buying and ginning station at this place. In the same year a Government Experimental Station was established at Tamale in the Northern Territories, at which special attention is being devoted to cotton cultivation. At this station systematic experiments have been arranged to determine a suitable and profitable rotation of crops to grow with cotton; to ascertain the best variety to grow; to produce, by selection and cross-fertilisation, improved strains of cotton, and also to find out the best times at which the different varieties should be planted. Experiments are also being conducted at the Government Experimental Station at Assuantsi, in the Central Province of the Gold Coast Colony.

In recent years particular attention has been paid by the British Cotton Growing Association to possible developments in the Northern Territories, and a small buying and ginning station was opened at Tamale, but the results so far have been disappointing. The British Government, however, have renewed for a period of three years a grant of £10,000 per annum to the Association towards the cost of their work in Nyasaland, Nigeria, and the Gold Coast, and the Association, according to their *Annual Report* for 1912, have therefore decided to carry on the work in the last-mentioned country for a further period. Arrangements have also been made by the Association to continue the buying station and ginning factory at Labolabo.

The Director of Agriculture in his report for 1911 states that cotton for the most part must be grown in the Gold Coast as a catch crop amongst foodstuffs, but even under the most favourable conditions only a very small yield per acre can be expected.

The exports of raw cotton from the Gold Coast in recent years, according to the official statistics, are as follows:

	Quantity. *lb.*	Value. £
1908	51,480	1,171
1909	31,290	790
1910	11,421	263
1911	9,701	238
1912	20,395	506

A considerable number of samples of cotton grown in the Gold Coast have been examined at the Imperial Institute. Some of the earlier samples were dealt with in *British Cotton Cultivation: Reports on the Quality of Cotton grown in British Possessions* (*Colonial Reports, Miscellaneous Series, No.* 50 [Cd. 3997], 1908, p. 28), and in this BULLETIN (1909, **7**, 14). In the following pages an account is given of the cottons received since that date. They comprise Improved American Upland and native varieties as well as a series of hybrid cottons produced at the Labolabo experimental plantation.

Improved American Upland Cottons

No. 1. *Nyasaland Upland.*—A sample of seed-cotton and one of lint grown at Labolabo were received in March 1911. The former yielded 32·8 per cent. of lint on ginning, the yield per 100 seeds being 4·2 grams. The seeds were of medium size and covered with a white fuzz.

The cotton was clean, fairly soft, moderately fine, lustrous, and of white to pale cream colour with occasional small yellow stains. It was of uneven strength, some portions being rather weak. The length of the fibres varied from 1·0 to 1·5 in., but was mostly from 1·2 to 1·3 in.

This cotton was of good quality, but was somewhat neppy, *i.e.* it contained specks or knots consisting of short, unripe fibres, and portions of it were rather weak. It was valued at about 6½*d.* per lb., with "middling" American at 5*d.* per lb. It was pointed out that if it was intended to grow this cotton in the future on a large scale in the Gold Coast great care would be required in connection with its acclimatisation. It was stated that it was of the highest

importance that seed for sowing should be carefully selected from those plants which showed the most desirable characters, and that this process should be repeated from year to year until a permanent type had been established. In this connection, reference was made to the method of selection recommended for this variety of cotton by the Director of Agriculture in Nyasaland in his report for 1909–10, which has been reprinted in this BULLETIN (1910, **8**, 372).

No. 2. Nyasaland Upland.—A sample of seed-cotton of this variety, which had been grown at Tamale, was received at the same time as the preceding sample. The yield of lint on ginning was 33·4 per cent., and the yield per 100 seeds 4·55 grams. The seeds were of small to medium size; some were coated with a white or greenish fuzz, whilst others were smooth and black, with a tuft of down at the pointed end.

The lint was clean, fairly soft and lustrous, moderately fine, of white to pale cream colour, and free from stains. It was of somewhat uneven strength, and varied in length from 1·0 to 1·5 in., but was mostly from 1·2 to 1·3 in.

This cotton was of very satisfactory quality and somewhat superior to the preceding sample of Nyasaland Upland from Labolabo, being of better lustre, free from stains, and not neppy. The chief defect was the irregular strength. It was valued at about 7*d.* per lb., ginned, with "middling" American at 5*d.* per lb. The cotton was very similar to samples of the same variety grown in Nyasaland which have been examined at the Imperial Institute (see this BULLETIN, 1912, **10**, 528).

No. 3. Nyasaland.—A second sample of Nyasaland seed-cotton grown at Tamale was received in July 1913. It yielded on ginning 30·2 per cent. of lint, the yield per 100 seeds being 3·22 grams. The seeds were of medium to large size, and mostly bearing varying quantities of long white, brownish, or greenish fuzz; some dark brown seeds without fuzz were also present.

The lint was clean, slightly "leafy," soft, lustrous, and of cream colour, with a few small and large yellow or brownish stains. The strength of the cotton was irregular,

but fair on the whole. Some weak immature fibre was present. The fibres varied in length from 0·8 to 1·4 in., but were mostly from 0·9 to 1·1 in.

This sample was very short for Nyasaland Upland and was decidedly inferior to that usually produced in Nyasaland. It was valued at 7½*d.* per lb., with "middling" American cotton at 7*d.* per lb.

No. 4. *Black Rattler.*—A sample of seed-cotton and one of lint of this variety, which had been grown at Tamale, were received in March 1911. The former yielded 39·0 per cent. of lint, the yield per 100 seeds being 5·21 grams. The seeds were small, in some cases covered with white or green down, whilst others were smooth and dark brown with a tuft of down at the pointed end.

The lint was clean, slightly coarse, fairly lustrous, of white to pale cream colour, and free from stains. It was of good strength, and varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·0 in.

This cotton was of satisfactory quality, but rather short and somewhat neppy. It was valued at about 5*d.* per lb., with "middling" American at the same price.

No. 5. *Black Rattler.*—This sample of seed-cotton was also grown at Tamale, and was received in July 1913. The yield of lint on ginning was 35·7 per cent., and the yield per 100 seeds 4·05 grams. The seeds were of medium to large size; some were dark brown, without fuzz, and others bore quantities of long white, brownish, or greenish fuzz.

The lint was clean, soft, lustrous, and of cream colour with occasional yellow or brownish stains. The strength was rather irregular, but fairly good on the whole. The length was also irregular, varying from 0·8 to 1·4 in., but mostly from 0·9 to 1·1 in.

The value of this cotton is reduced by its uneven length and strength, as well as by the presence of stains. It was valued at 6½*d.* per lb., with "middling" American cotton at 7*d.* per lb.

No. 6. *Black Rattler.*—This sample of seed-cotton was grown at Assuantsi, and was received in March 1911. It yielded on ginning 38·4 per cent. of lint, the yield per 100 seeds being 5·6 grams. The seeds were of medium

size, and mostly covered with grey or green down, whilst a few were smooth and dark brown with a tuft of down at the pointed end.

The lint was soft, fairly fine and lustrous, of white to cream colour, and free from stains. The strength was fairly good, and the length ranged from 0·7 to 1·1 in., but was mostly from 0·9 to 1·0 in.

This sample of Black Rattler cotton was very similar to No. 4 from Tamale, but was slightly superior, being less neppy. It was valued at about $5\frac{1}{4}d.$ per lb., ginned, with "middling" American at $5d.$ per lb.

No. 7. Jones's Improved.—This sample of seed-cotton grown at Tamale was also received in March 1911. The yield of lint on ginning was 35·5 per cent., the yield per 100 seeds being 6·3 grams. The seeds were large and covered with a fuzz varying in colour from pale brown to green.

The lint was clean, fairly soft, lustrous, fine, of cream colour, and free from stains. The strength was uneven, most of the cotton being rather weak. It was of irregular length, the fibres varying from 0·7 to 1·3 in., but mostly from 0·8 to 1·0 in.

This sample was inferior to the usual growth of "Jones's Improved" cotton, being of short and irregular length and uneven strength. It was valued at about $5\frac{1}{4}d.$ per lb., ginned, with "middling" American at $5d.$ per lb. If the plant were carefully acclimatised it would probably yield a product of more regular character.

No. 8. Jones's Improved.—A further sample of seed-cotton of this variety, grown at Tamale, was received in July 1913. It yielded on ginning 34·4 per cent. of lint, the yield per 100 seeds being 3·9 grams. The seeds were large, and mostly covered with long white, brownish, or greenish fuzz; a few dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, and of cream colour, with a few small yellow or greenish stains. It was of fairly good strength, and varied in length from 0·9 to 1·2 in., but was mostly from 1·0 to 1·1 in.

This cotton was unusually short for the "Jones's Im-

proved" variety. It was valued at 6¾*d.* per lb., with "middling" American cotton at 7*d.* per lb.

No. 9. *Jones's Improved.*—This sample of seed-cotton was grown at Assuantsi, and was received in March 1911. The yield of lint, on ginning, was 35·3 per cent., and the yield per 100 seeds 4·9 grams. The seeds were of medium size, and mostly covered with a pale brown down, whilst a few seeds were smooth, and bore tufts of down at the pointed end.

The lint was clean, fairly soft and lustrous, fine, white to deep cream in colour, and free from stains. It was of good strength and varied in length from 0·7 to 1·2 in., but was mostly from 0·9 to 1·1 in.

This material was very similar to the sample of "Jones's Improved" cotton from Tamale (No. 7), but it was a little stronger. It was valued at about 5¼*d.* per lb., ginned, with "middling" American at 5*d.* per lb.

No. 10. *Hawkins.*—A sample of seed-cotton grown at Assuantsi was received in March 1911. It yielded, on ginning, 36·4 per cent. of lint, the yield per 100 seeds being 5·3 grams. The seeds were of medium size, and were mostly smooth, with small brownish tufts at the pointed end, whilst a few seeds were covered with a pale brown down.

The lint was clean, fairly soft, fine, moderately lustrous, of cream colour, and free from stains. It was of irregular strength, and varied in length from 0·7 to 1·3 in., but was mostly from 0·9 to 1·0 in.

This sample resembled the sample of "Jones's Improved" cotton from Tamale (No. 7), and the remarks made regarding the latter sample apply also in this instance. It was valued at about 5¼*d.* per lb., ginned, with "middling" American at 5*d.* per lb.

No. 11. *Hawkins.*—A sample of seed-cotton of this variety, grown at Tamale, was received in July 1913. The yield of lint, on ginning, was 33·2 per cent., and the yield per 100 seeds 4·43 grams. The seeds were large, and covered with varying amounts of long, white, brownish, or greenish fuzz.

The lint was clean, soft, lustrous, and of cream colour

with occasional fairly large yellow or brownish stains. The strength of the cotton was irregular, and on the whole rather poor. It varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·1 in.

This sample was rather shorter than is usual for cotton of the "Hawkins" variety, while its value was further reduced by its uneven length, as well as by the presence of stains. It was valued at 7*d.* per lb., with "middling" American cotton at the same price.

No. 12. *Upland.*—This seed-cotton was grown at Tamale, and was received in July 1913. It yielded on ginning 32·2 per cent. of lint, the yield per 100 seeds being 3·96 grams. The seeds were of medium to large size, and mostly covered with varying amounts of long white, brownish, or greenish fuzz; some dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, and of cream colour, with occasional small yellow or brownish stains. It was of irregular strength, but on the whole fairly good. The length was also irregular, the fibres varying from 0·8 to 1·5 in., but mostly about 0·9 to 1·1 in.

This cotton was somewhat less stained than No. 11, but exhibited the same defects with regard to length and strength. It was valued at 6¾*d.* per lb., with "middling" American cotton at 7*d.* per lb.

Native Cottons

No. 13.—This sample of seed-cotton, which was received in April 1909, was grown experimentally on the Ankobra river, near Axim. The name of this variety was not stated, but it was probably a native cotton. It yielded 39 per cent. of rather rough, fairly lustrous lint of pale cream colour, with a large proportion of brown and yellow stains. The seeds were rather large, smooth, dark brown, with light brown tufts at the pointed ends. Groups of from two to six lightly adhering "kidney" seeds were occasionally noticed. Thirty per cent. of the seeds examined were withered, and would be useless for sowing.

The cotton was of uneven strength, some portions

being very weak. The length of the fibres varied from 1·2 to 1·6 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

This sample was valued at about 6*d.* per lb. ginned, with "middling" American at 5·54*d.* per lb., but although worth more than "middling" American cotton it was depreciated in value by the large proportion of stains, which appeared to have been caused by insect pests in the crop. If the cotton could be produced clean and free from stains it would probably be considerably more valuable than "middling" American, as it is of very good length. The somewhat high yield of lint on ginning is probably to be attributed to the large percentage of withered seeds in the sample rather than to a naturally high proportion of lint to seed.

No. 14. *Green Seed.*—This sample of ginned cotton was received in July 1909. It was very clean, fairly soft, lustrous, of very even pale cream colour, and entirely free from stains. The strength was uneven, some portions being rather weak. The length of the fibres varied from 1·0 to 1·4 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·00079 in.

This cotton had been hand-ginned, and cleaned by the native "bowstring" method, which had very completely removed all portions of "leaf" and broken capsules. Commercial experts stated that the sample was "wonderfully clean." The cotton was somewhat harsher than ordinary American cotton, and was rather weak, but it was of satisfactory quality, and might be used in place of American Upland. It was valued at about 7*d.* per lb., with "middling" American at 6·39*d.* per lb.

No. 15. *Green Seed.*—A sample of seed-cotton of this variety, grown at Tamale, was received in July 1913. It yielded on ginning 32·9 per cent. of lint, the yield per 100 seeds being 4·37 grams. The seeds were large, and covered with long, brown, bright green, or white fuzz; a few dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, varying in colour from light brown to almost white, with several small yellowish or brownish stains. It was rather irregular in

strength, but good on the whole. The length of the cotton was very irregular, varying from 0·8 to 1·7 in.

This cotton was thought to be worth 6½*d.* per lb., with "middling" American cotton at 7*d.* per lb. Its value was reduced by its uneven colour and irregular length.

No. 16.—This sample of ginned cotton, which was also received in July 1909, was stated to be the ordinary Northern Territories variety, and was grown on the Labolabo Plantation. It was clean, fairly soft, but not very lustrous, of pale cream colour, and generally free from stains. The strength was normal, and the length varied from 0·9 to 1·2 in., the diameter of the fibres ranging from 0·0005 to 0·0010 in., with an average of 0·00076 in.

This cotton was somewhat harsher than Upland cotton, but it would have similar commercial applications, and would be readily saleable. It was valued at about 6·70*d.* per lb., with "middling" American at 6·39*d.* per lb.

No. 17.—This sample, which was stated to be "Tudome native, a Peki variety," was received at the same time as the preceding sample. It consisted of clean ginned cotton, rather rough, not very lustrous, but of even cream colour, and entirely free from stains. It was of normal strength, and varied in length from 1·0 to 1·3 in.; the diameter of the fibres ranged from 0·0005 to 0·0011 in., with an average of 0·00082 in.

This cotton was valued at about 6·90*d.* to 7*d.* per lb., nominal, with "middling" American at 6·39*d.* per lb. It was of similar character to Peruvian cotton, and it is possible that it might have similar commercial applications, in which case it would realise a higher price than that quoted. The sample was of very good appearance, and cotton of this quality would be readily saleable.

No. 18.—This cotton from the Dagomba district, Northern Territories, was received in March 1911. It consisted of ginned cotton, clean, somewhat harsh, fairly fine, curly, lacking in lustre, white and free from stains, and fully mature. It was of good strength, and varied in length from 0·9 to 1·1 in.

This cotton was of excellent colour, but of somewhat dull appearance and rather short. It was not rough

enough to compete with "rough" Peruvian, but would no doubt find a ready sale. It was valued nominally at 8·67*d.* per lb., with "middling" American at 8·37*d.* per lb. It would be desirable to study the behaviour of this variety under cultivation, and to determine the yield of cotton obtainable, as it possesses the advantage of being already acclimatised and would probably give a valuable crop.

No. 19.—A sample of seed-cotton and one of the lint of a native variety grown at Peki were received in March 1911. The former yielded 36·1 per cent. of lint, on ginning, the yield per 100 seeds being 5·6 grams. The seeds were small and dark brown and were free from fuzz, except for a small tuft at the pointed end.

The lint was rather harsh, of fair lustre, of white to pale cream colour, and free from stains. It was of good strength and varied in length from 0·8 to 1·3 in., but was mostly from 0·9 to 1·1 in. The diameter of the fibres ranged from 0·0007 to 0·0011 in., with an average of 0·00080 in.

This sample was of good useful quality, and the cotton would be well worth cultivating. It is probable that it might be considerably improved by careful seed selection. It was valued at about 5¼*d.* to 5½*d.* per lb., with "middling" American at 5*d.* per lb.

No. 20. *Dagomba Native.*—A sample of seed-cotton, and one of the lint of this variety grown at Tamale, were received at the same time as the preceding sample. The seed-cotton yielded, on ginning, 26·2 per cent. of lint, the yield per 100 seeds being 2·5 grams. The seeds were rather small and more or less covered with a white down.

The lint was clean, soft, fairly lustrous, of pale cream colour and free from stains. It was rather weak, and varied in length from 0·8 to 1·3 in., being mostly from 0·9 to 1·1 in. The diameter of the fibres ranged from 0·0006 to 0·0009 in., with an average of 0·00078 in.

This sample was similar to the preceding sample of native cotton grown at Peki (No. 19), but was somewhat softer. It was valued at about 5½*d.* per lb., with "middling" American at 5*d.* per lb. The cotton is of good serviceable quality and could doubtless be improved by

cultivation. The yield on ginning, viz. 26·2 per cent., is rather low.

No. 21. *Dagomba Native.*—This seed-cotton was grown at Tamale and received in July 1913. It yielded on ginning 27·9 per cent. of lint, the yield per 100 seeds being 2·54 grams. The seeds were of medium size, and mostly covered with long white, brownish or greenish fuzz; some dark brown seeds without fuzz were also present.

The lint was clean, soft, lustrous, of cream colour, and practically free from stains. It was of fairly good strength, but rather irregular in length, varying from 0·8 to 1·3 in., but mostly from 0·9 to 1·1 in.

This sample was of very good appearance, but was a little irregular in length. It was valued at 6¾*d.* per lb. with "middling" American cotton at 7*d.* per lb.

No. 22.—A sample of ginned cotton and one of cotton seeds of an indigenous variety, from the Gambaga District of the Northern Territories, were received in April 1913. The lint was clean, rather harsh, curly, of moderate lustre, of pale greyish-cream colour, and free from stains. The seeds were of medium size, and covered with fairly long bright green or brownish fuzz.

The cotton was of fair strength, but rather irregular in length, varying from 0·8 to 1·5 in., but mostly from 0·9 to 1·1 in. The diameter of the fibres ranged from 0·00060 to 0·0013 in., with an average of 0·00085 in. On microscopical examination it was found that many of the fibres were deficient in twist, probably owing to lack of cultivation of the plant.

This cotton was rather coarse and harsh, and possessed to some extent the characteristics of wild cottons. The fibre was, however, of promising quality and could possibly be considerably improved if the plants were systematically cultivated. On account of its rough character it would probably be of special value for admixture with wool in the manufacture of the so-called "union" yarns. It was valued at from ½*d.* to 1*d.* per lb. in advance of "middling" American cotton, which at the date of the report was quoted at 6·79*d.* per lb. (May 1913).

Herbarium specimens forwarded with the cotton were

identified at the Royal Botanic Gardens, Kew, as *Gossypium arboreum*, Linn. Several samples of this species of cotton from Northern Nigeria have already been examined at the Imperial Institute (see this BULLETIN, 1913, **11**, 76).

No. 23. *Native Black Seed.*—This seed-cotton was grown at Tamale, and was received in July 1913. The yield of lint on ginning was 27·4 per cent., and the yield per 100 seeds, 2·44 grams; the seeds were of medium size, and covered with long white or brownish fuzz; a small number of dark brown seeds without fuzz were also present.

The lint was clean, fairly soft, of fairly good lustre, and varying in colour from a brownish tint to almost white, with several small yellow or brownish stains. It was of fairly good strength, and varied in length from 0·8 to 1·2 in., but was mostly from 0·9 to 1·1 in.

This cotton was of rather poor colour and appearance. It was valued at 6¼*d.* per lb. with "middling" American cotton at 7*d.* per lb.

No. 24. *Peki.*—This seed-cotton was also grown at Tamale, and was received at the same time as the preceding sample. It yielded on ginning 36·4 per cent. of lint, the yield per 100 seeds being 5·57 grams. The seeds were large and dark brown, without fuzz; many adhered together in "kidneys" of six seeds, which were mostly more or less broken up during ginning.

The lint was clean, slightly harsh, lustrous, and of cream colour, with several small yellowish or brownish stains. It was of good strength, but rather irregular in length, varying from 0·8 to 1·5 in., but mostly from 1·1 to 1·3 in.

This cotton was on the whole of very satisfactory quality. It was valued at 7*d.* per lb. with "middling" American cotton at the same price.

Hybrid Cottons

The following samples of ginned cottons were received in October 1909. As already mentioned, they were produced experimentally at the Labolabo Plantation. At the date of valuation of the samples "middling" American cotton was valued at 6·79*d.* per lb.

No. 25. *Green Seed on Black Rattler.*—This cotton was

clean, fairly soft, of good lustre and even cream colour; entirely free from stains. It was of normal strength, and varied in length from 1·2 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This cotton generally resembled that grown from a good type of "improved" American seed. It was slightly harsher than Upland cotton, but was of very good length and of excellent quality. It was valued at 8·79*d.* per lb. (nominal).

No. 26. Black Rattler on Native.—This sample was similar in appearance to No. 25. It was of very good strength, and varied in length from 1·4 to 1·6 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00071 in.

The cotton was superior in length to the preceding sample, "Green Seed on Black Rattler," but in other respects no difference could be observed. It was valued at 9·29*d.* per lb. (nominal).

No. 27. Peruvian on Native.—Clean cotton, rather harsh, of fair lustre, and of somewhat uneven cream colour with some slight brownish-yellow stains. Some portions were rather weak. The length of the fibres varied from 1·0 to 1·3 in., and their diameter ranged from 0·0005 to 0·0012 in., with an average of 0·00076 in.

This cotton had the style of a native cotton. It was harsher than American Upland, but not sufficiently "woolly" to be comparable with "rough" Peruvian. The cotton, although slightly stained and immature in parts, was of fairly good quality, and would no doubt be readily saleable. It was valued at 6·94*d.* to 7·04*d.* per lb.

No. 28. Black Rattler on Green Seed.—This cotton was clean, rather harsh, of fair lustre and even colour, and generally free from stains. It was of normal strength and varied in length from 1·0 to 1·3 in. The diameter of the fibres ranged from 0·0005 to 0·0011 in., with an average of 0·00075 in.

Although of better quality, this cotton appeared to be of very similar type to the preceding sample, "Peruvian on Native," and it is possible that these two samples may not

be true hybrids, as stated, but simply the native forms. The cotton was valued at 7·09*d.* per lb.

No. 29. *Allen's Improved on Native.*—Clean cotton, rather harsh, lustrous, and of even cream colour; entirely free from stains. The strength was generally normal, and the length varied from 1·2 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00073 in.

This cotton would probably be classed as a good quality of Upland. The material was slightly harsher and deeper in colour than ordinary Upland cotton, but generally resembled it in other respects. It was valued at 7·19*d.* to 7·29*d.* per lb.

No. 30. *Russell's Big Boll on Native.*—This cotton was similar in appearance to the preceding sample, "Allen's Improved on Native." It was of normal strength, and varied in length from 1·1 to 1·4 in. The diameter of the fibres ranged from 0·0005 to 0·0011 in., with an average of 0·00075 in.

Although slightly inferior in length, this cotton closely resembled the preceding sample, and it was valued at the same price.

No. 31. *Culpepper's Big Boll on Native.*—This was clean, rather harsh cotton, of fair lustre and deep cream colour, with some slight brownish-yellow stains. It was of uneven strength, some portions being rather weak. The length of the fibres varied from 1·1 to 1·3 in., and their diameter ranged from 0·0005 to 0·0010 in., with an average of 0·0007 in.

This material was slightly harsher than Upland cotton. It was of good quality, and worth from 6·94*d.* to 7·04*d.* per lb., but it was depreciated in value by its somewhat inferior colour.

No. 32. *Richmond on Native Green Seed.*—Clean cotton, rather harsh, of fair lustre and even deep cream colour, and generally free from stains. The strength was generally normal, and the length varied from 1·0 to 1·3 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00075 in.

This material was slightly harsher than Upland cotton,

but was of very good quality, and would be readily saleable. It was valued at 7·09*d.* per lb.

No. 33. *Richmond on Volta River.*—Clean cotton, fairly soft, lustrous, and of even deep cream colour; entirely free from stains. Occasional smooth brown seeds, with light brown tufts at the pointed ends, were found in the sample. The cotton was of normal strength, but rather uneven in length, varying from 1·1 to 1·5 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00071 in.

This sample was of very good quality, and about equal to a high grade of Upland cotton. It was valued at 7·19*d.* to 7·29*d.* per lb.

No. 34. *Black Rattler on Volta River.*—This cotton was similar in appearance to the preceding sample, "Richmond on Volta River." It was of normal strength, and varied in length from 1·1 to 1·4 in. The diameter of the fibres ranged from 0·0005 to 0·0010 in., with an average of 0·00074 in.

This sample, like the preceding, "Richmond on Volta River," was of very good quality, and about equal to a high grade of Upland cotton. It was valued at 7·19*d.* per lb.

No. 35. 1904 *Hybrid.*—Clean cotton, rather harsh, of fair lustre and even cream colour; entirely free from stains. It was of uneven strength, some portions being rather weak. The length varied from 1·0 to 1·3 in., and the diameter ranged from 0·0005 to 0·0011 in., with an average of 0·0008 in.

Although portions of this sample were immature, and consequently of poor strength, the cotton generally was of very good quality. It was valued at 7·04*d.* per lb.

Several of these eleven samples of hybrid cottons were rather harsh and distinctly "woolly." It was therefore considered possible that they might find a market as rough varieties, similar to "semi-rough" or "rough" Peruvian cotton, in which case they might realise higher prices than those quoted in the present report.

SPECIAL ARTICLES

THE CANADIAN DEPARTMENT OF AGRICULTURE

By J. H. Grisdale, B.Agr.

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What is known as the Canadian or Dominion Department of Agriculture, as differentiated from the various Provincial Departments of Agriculture in Canada, has to do with such matters as affect all parts of the Dominion or with lines of work that are of such a character as to be likely to lead to complications should it be attempted to deal with them locally. It must be understood, however, that many of the matters dealt with by the Dominion Department do also receive attention, usually to a more limited extent, from the Provincial Departments.

As at present constituted, those Branches of the Dominion Department of Agriculture having to do with agriculture are: Health of Animals, Live Stock, Dairying and Cold Storage, Seeds, and Experimental Farms, with various other more or less important but subsidiary divisions.

The Health of Animals Branch, under an officer known as the Veterinary Director-General, is charged, of course, with the enforcement of the various laws and regulations for the prevention and control of contagious diseases affecting live stock in Canada. It has likewise to do with the regulations under which live stock may be brought into and taken out of the country. It has in its employ for this purpose many veterinary inspectors scattered throughout the various provinces as well as located at the various ports of entry and animal quarantine stations. The administration of the Meat Inspection Act also comes under this Branch. According to this Act, every abbatoir and meat-packing plant preparing meat of any kind for export must be under the constant supervision of qualified inspectors in connection with their slaughtering, curing, and packing operations.

The Live Stock Branch, under the Live Stock Commissioner, devotes much of its energies to the marketing end of the live-stock industry in the Dominion. Besides this, however, it is concerned with popularising the various selected breeds of horses, cattle, sheep, swine, and poultry, and employs men whose duties are to advance Canadian live-stock interests by lecturing, by judging at small fairs, by taking part in short courses of instruction, and in any and every way that offers. What are known as the National Live Stock Records, while not actually a part of this Branch, may be said to be closely allied thereto. The Canadian Record of Performance for Dairy Cows is another division of this Branch ; it, also, is doing good work.

The Dairy and Cold Storage Branch, under the supervision of a Commissioner of Dairying and Cold Storage, concerns itself with the advancement of the dairying interests in a general way throughout the Dominion. Dairying is, of course, a line of work very closely followed by the Provincial Governments, with whose Agricultural Departments this Branch co-operates. This Branch is, however, doing much independent work to advance the interests of dairying, as, for instance, experimenting in the manufacture of butter and Cheddar cheese and in studying methods of milk preservation. Cow Testing Associations are also being organised and helped by this Branch at many points in the country. The Act providing for subventions to cold storage plants used as public cold stores is administered by the Dairy and Cold Storage Branch.

The Seed Control Act is administered by the Seed Branch, at the head of which is the Seed Commissioner. A close inspection is made at the proper time of all stores of seed and of seed of various kinds exposed for sale. Seed is required to be properly graded and to come up to a certain standard as regards purity and vitality. In addition, the Canadian Seed Growers' Association may be said to exist under the ægis of this Branch.

The various Branches already mentioned are concerned more or less exclusively, as is evident, with the encouragement of agriculture by controlling and regulating rather

than by investigating and demonstrating. The research and demonstration work done by the Dominion Government in agricultural matters is practically all carried on at one or other of the various Experimental Farms which form the Dominion Experimental Farm System. The Experimental Farms or Stations, together with the sub-stations, now number about twenty-five. They are found in every province and in every latitude from about 46 to 62 degrees, or nearly so, north—a range of approximately 1,100 miles from south to north, and a stretch of country about 3,000 miles from east to west.

The Farm at Ottawa, Ontario, is known as the Central Experimental Farm. On this Farm are located the Director of Dominion Experimental Farms and the various officers in charge of the different lines of investigation both at the Central Farm and at the various Branch Farms and Stations. The latter are under the immediate supervision of officers known as Superintendents, who work conjointly with the Director and the various officers at Ottawa in the conduct of experimental and demonstration work.

The Director is responsible in a general way for the activities of the various officers or heads of Divisions and Branch Farm Superintendents. He is also the executive head of the system, and deals with its general policy and financial business.

The chief officers under the Director, at Ottawa, are ten in number and are known as Dominion officers. They include the Animal Husbandman, Field Husbandman, Cerealist, Horticulturist, Agrostologist, Botanist, Entomologist, Poultry Husbandman, Chemist, and Tobacco Expert.

Recently, owing to the establishment of new Farms and Stations, the increase in the number of officers, and the consequent multiplication of purely executive and directorial duties, the Director, who formerly carried on more or less experimental work under his own personal supervision, has been compelled to discontinue this, and to devote his entire attention to the general supervision of the work of the various officers, and to the formulation of policies and general schemes of work for the further development of the Experimental Farm system.

The Dominion Animal Husbandman is charged with the study of live-stock breeding and feeding operations. Much has already been done to show the possibilities of improving the productive power of the various breeds of horses, cattle, sheep, and swine, in the way of labour performance, meat production, milk yield, or other functions. The research work in this division has indicated the possibility of more economical feeding and more effective methods of working the horse; while, by careful and scientific breeding, farmers have been shown the possibility of increasing the efficiency of their dairy herds by from 50 to 200 per cent. The cattle-carrying power of the average eastern farm has been increased by from 50 to 100 per cent.; while the cost of feeding cattle has been largely reduced by the complete change of methods which followed the introduction of the silo, for which, in Canada, the Experimental Farms Branch may be largely thanked.

Unfortunately the advantages accruing from more economical methods of feeding have been possibly even more than counterbalanced by the increased cost of manual labour and the rising value of land. In spite of this, however, the performance of cultural operations according to methods which have proved most effective, judging by results, and most economical of labour, will keep the cost of crop production as low, if not lower, than when lands were very much cheaper, and when wages were a half or less than half of what they are now.

The Dominion Field Husbandman has to do with crop rotation and soil cultivation. Experiments conducted by this division have demonstrated almost incredible possibilities of soil improvement and crop production, where the cultural operations are thorough, and where scientific methods are followed.

The average farmer in Canada in 1912 expended $10.00 per acre in the way of labour on his farm; he reaped crops to the value of $15.50 per acre on the average, leaving a net profit of $5.50 per acre. On the Experimental Farm at Ottawa, with no special advantages of climate or soil, and having no manure other than that from the farmyard, the expenditure per acre was $11.77 in the carrying out of

cultural operations in a thorough and scientific manner, following at the same time suitable rotations; the crops produced averaged $45.47 per acre in value, leaving a net profit of $33.70 per acre, which is over six times greater than the average Canadian farmer, working under quite as favourable natural conditions in every way, was able to achieve.

The attention of the Dominion Cerealist has been given for many years to some of the gravest problems which have confronted new settlers in the prairie provinces. Much time has been devoted to the production and introduction of new and improved varieties of cereals adapted to the peculiar conditions which have been encountered there. The free distribution by post of 5 lb. samples of pure seed grain from Ottawa, and the sale of seeds in quantities of usually from 2 to 5 bushels from the Branch Experimental Farms, have been the chief means by which the superior types of grain have been supplied to the farmers. As a means of instruction, and for the demonstration of the characteristics of the different varieties, many trial plots have been grown every year at each of the Farms.

Spring wheat has naturally occupied the first place in this work, on account of its paramount importance, especially to new settlers. Many thousands of samples of "Red Fife," the old standard variety, have been distributed, especially in Manitoba and Southern Saskatchewan. Selections have been made from this wheat to ensure the maintenance of its purity and to effect improvements if possible. For northern districts and those of higher altitude, early-ripening sorts have been found essential. Many such wheats have been tested from time to time, both imported and new cross-bred kinds. Such varieties as "Preston," "Huron," and "Stanley" served a splendid purpose in making wheat-growing profitable in localities for which "Red Fife" was quite unsuitable; but these wheats have lately been surpassed by "Marquis," a cross-bred sort introduced into Saskatchewan by the Dominion Cerealist in 1907, and which has maintained a triumphal progress ever since, such as has probably never occurred

before in the history of agriculture (cf. this BULLETIN, 1912, **10**, 151).

"Marquis" has usually out-yielded "Red Fife" by from 10 to 70 per cent., according to the varying conditions of the test, due to its greater earliness, stiffness of straw, and ability to resist disease. The kernels are hard and exceptionally plump, and of a splendid rich colour. The flour from this wheat is practically indistinguishable from "Red Fife" flour. The highest recorded yields of "Marquis" have been obtained at Indian Head, where in 1910 a field of 5 acres gave more than 53 bushels per acre, and in 1912 a fortieth-acre plot yielded at the rate of 81⅓ bushels per acre. No wonder that "Marquis" wheat has defeated the world in the two greatest wheat contests held since its introduction—at New York in 1911 and at Lethbridge in 1912. Until about the year 1910 "Marquis" wheat was obtainable only from the Experimental Farms, but to-day it is offered for sale by many different firms and individuals. Hundreds of thousands of bushels of this wheat have changed hands during the past winter at good prices, and if one may judge from the correspondence which reaches the Experimental Farms, and from the advertisements in agricultural papers, "Marquis" wheat is to-day more thought of and talked about in Western Canada than all the other varieties of grain together.

But "Marquis" is not the last word in wheat-breeding. This year a much earlier sort, under the suggestive name of "Prelude," is offered to the public (*loc. cit.* p. 152). This wheat ripens about two weeks before "Marquis," produces kernels of remarkable hardness and plumpness, and gives flour of the highest baking strength. It will not yield as large crops as "Marquis," and is not intended to displace that variety, but is adapted to northern districts where "Marquis," especially on summer-fallowed land, is apt to produce too long straw and to ripen too late. Though not expected to produce phenomenal yields, a crop of over 10 bushels obtained in 1912 by sowing 5 lb. on a fifth of an acre is a very satisfactory record to begin with.

Many new cross-bred wheats, ripening earlier than "Marquis" and later than "Prelude," are now being tested,

and the introduction of at least one of these may be looked for in the near future. One of the most promising of these varieties, not yet named, produced 54½ bushels of superb seed on an acre field at Indian Head during last season. A similar field of "Marquis" near by ripened two days later and gave 47 bushels per acre.

The progress in barley-breeding has been less rapid owing to the limitations of land and assistance for carrying on the work. Some hundreds of very interesting cross-bred barleys are now under study, including some sorts with remarkably stiff straw, also beardless and hull-less varieties both in the six-row and two-row classes. Thus far the most important result which has reached the public is the introduction of an improved, selected Manchurian barley, which is now being distributed and sold.

Problems in oats are being worked at, and some good selections have been made. Cross-bred sorts are also under study.

In peas a cross-bred variety, "Arthur," now stands at the head of the list for most parts of Canada. It is a round, yellow pea of medium or rather large size, producing the pods chiefly towards the tip of the stem, and giving a very large yield of seed. In addition to its other good qualities, it is the earliest maturing pea of its kind known in Canada. It is hoped that the introduction of this new variety will give a distinct stimulus to the growing of this important farm crop.

The Dominion Horticulturist has immediate supervision on the Central Farm over quite extensive orchards, ornamental grounds, and vegetable gardens, but he is also expected to supervise, in a general way, horticultural operations all over the system. Besides this he is occupied largely in breeding experiments for the production of early and superior varieties of fruits, vegetables, and flowers. The possibilities on these lines of work are exceedingly great, and while progress is necessarily slow, gratifying results seem certain.

The Dominion Agrostologist, like the other officials, spends much of his time in Ottawa, having trial grounds whereon breeding operations with grasses, roots, and other

forage plants are carried on. He is responsible for the improvement of forage crop plants in every part of Canada, and has more or less experimental work under way at different points.

The Dominion Botanist has his herbarium in the office building of the Central Farm, but is, of course, familiar with plant life in all parts of Canada, and is at all times ready to identify specimens of plants or to diagnose diseases affecting plants if specimens of plants suffering from the disease are sent him.

The Dominion Entomologist, with headquarters at Ottawa, is occupied primarily in enforcing the regulations of the Destructive Insect and Pest Act. His inspectors are scattered throughout the Dominion, from the Atlantic to the Pacific, and while chiefly occupied in the enforcement of the above-mentioned regulations, also give much attention to the study of insects injurious to plant life. Insects sent in are promptly identified, and where any treatment likely to put an end to their depredations is known, the information is sent at once to the inquirer. One of the members of the staff of the Dominion Entomologist is a skilled apiculturist.

The Dominion Poultry Husbandman, in addition to being in charge of poultry work at the Central Farm, is also indirectly in charge of such work on the Branch Farms. He is available for information or help in every province and district in Canada, and has under way much valuable work at the Central Experimental Farm, where some five acres of land are allocated to experimental work with poultry.

The Dominion Chemist, with commodious laboratories on the Central Farm, is occupied with the study of problems of soil fertility, moisture conservation, utilisation of manures, the feeding values of rough and concentrated cattle foods, etc. Much work is also done on insecticides, food preservatives, and drinking waters. Though the laboratories are at Ottawa, research work on these lines is by no means confined to this one Farm, as many acres of land are devoted to such work on the various Branch Farms throughout the Dominion.

The Tobacco Specialist, the tenth officer of the staff of Chief Officers, has under his supervision two special tobacco-growing Stations, where investigations on methods of growing tobacco and the testing of varieties are being carried on.

At the Branch Farms many lines of work are under way. Problems in soil improvement, crop production, horse, cattle and sheep breeding, beef, milk, and pork production, horticulture, gardening, poultry-raising, bee-keeping, etc., receive attention at them all. While all the farms do more or less work on practically all these lines, almost every Branch Farm is distinguished for special work in some particular branch.

Crop production is naturally one of the most important lines of work on the various Branch Farms, and the work in progress for the last fifteen years has demonstrated in almost every part of the country the importance of the introduction of a suitable crop rotation, along with the thorough application of the well-established principles of soil cultivation as the condition of success. Most extensive experiments to gain information as to methods of cultivation, or soil treatment most effective in conserving soil moisture, have been under way for some time, but it is still too early to report progress.

The investigations into beef production in the various provinces have shown that, while grain-growing is profitable, the combination of grain-growing with beef production is much more remunerative in almost any given year, and incomparably more advantageous in a series of years, especially if the conservation of soil fertility and the steady employment of labour be considered.

The very extensive researches into milk production have tended to elucidate many of the problems that puzzled the dairyman on the farm, and have enabled him and encouraged him to make his dairying operations not only remunerative, but highly profitable, in spite of the rather low prices that are paid for milk and its manufactured products. Where the best methods, as determined by experiment on many of these Farms, are put into practice,

results show that from 50 to 200 per cent. of clear profit may be confidently anticipated.

Work with swine on these Farms has helped to solve many of the difficulties that seemed to make profitable pork production, on anything like a commercial scale, almost impossible in many parts of the Dominion, on account of climatic conditions. One of the most notable improvements, which has probably done more than any other to help this industry, was the introduction of the cabin or out-door method of wintering the brood sow. This, together with the clover and mangel ration, rendered it possible for the farmer, even in the coldest parts of the country, to reduce by one-half the cost of producing young pigs fit to start in as feeders, and has, at the same time, more than doubled the chances of good, large, strong litters.

The work with sheep, while not yet so effective as it is hoped it will be ultimately in inducing Canadian farmers to take up this industry on a large scale, is, at the same time, attracting attention by the results obtained, which demonstrate clearly that good profits are possible in this industry, although the rapid falling off in the sheep population in the past few years might lead one to assume the contrary.

Poultry and bees are now coming in for much attention at the Branch Farms, as it is becoming more and more evident that they constitute an excellent combination for the small holder, who is gradually becoming a factor to reckon with in rural life in Canada.

Horticulture, as might be expected, is considered of primary importance on all the Branch Farms. Not only is this the case, but certain of the Farms are recognised as being Horticultural Farms, experimental work with fruit being by far the most important features of their operations. Vegetable gardening also has received much attention, and much exceedingly valuable information as to suitability of varieties and most satisfactory methods of growing, as affected by climatic or soil peculiarities, has been gained.

AGRICULTURE IN HAUSALAND, NORTHERN NIGERIA

By P. H. Lamb

Director of Agriculture in Northern Nigeria

Travellers to Kano have often referred to the fertility of the Hausa plains, and to the intensive methods of farming practised by the Hausa. The object of the present article is to consider how far this reputation for fertility is justified, and to discuss the processes—natural and artificial—by which such measure of fertility as does exist is maintained or otherwise from year to year under the system of agriculture generally in vogue.

In reviewing this subject it should be stated at the outset that the remarks here made have no application to small areas of irrigable land adjoining rivers, which must be put under an entirely separate category. The great bulk of the arable land around Kano consists of gently undulating plains covered with a surface soil of very light, sandy loam, originally derived from crystalline rocks, but greatly metamorphosed by the combined action of wind and water.

The whole country is annually exposed to the "Harmattan"—a dry wind from the north—which blows almost continuously from October to April inclusive. At this season of the year little or no rain falls. Under these circumstances the cultivation of the soil for annual crops is practically limited to the five months beginning with May and ending with September. During this period there is a fairly well distributed rainfall, generally totalling from 25 to 35 in.

The two principal food crops of the Hausas are the millets, *Sorghum vulgare*, and *Pennisetum typhoideum*. Cow peas (*Vigna* spp.), almost invariably grown in conjunction with the cereals, may fairly be classed third in importance. Ground nuts would probably come fourth. Other very common crops grown on a smaller scale than the first four, but generally claiming some attention on every farm,

and influencing very materially the dress, and therefore the national identity of the people, are cotton and indigo.

As stated above, travellers when discoursing upon Kano and its environs almost invariably speak of the surrounding cultivation as though it practically amounted to one vast garden of remarkable fertility. Surely in view of the fact that the Kano Province has an area of approximately 28,600 square miles, with a population estimated at 3,500,000, it would be a very remarkable thing indeed if there was not a large area of land under cultivation, and if the whole countryside did not look very green and the ground well occupied, for the only five months in the year when it is possible to make the desert smile.

But to the agriculturist this widespread verdure is hardly conclusive of great fertility. On the other hand, the ready response of the land to the smallest dressing of farmyard manure would seem to go a long way to show that natural fertility is rather the factor lacking.

In the immediate vicinity of large towns, and notably of Kano itself, a considerable quantity of manure of various kinds (principally derived from cattle, horses, sheep, and goats) is available, and is turned to good account, being transported either on the head or by means of pack-donkeys, and applied to the land. In some out-districts herds of cattle, fed in the bush by day, are kraaled on the land at night, thus contributing enormously to its productivity.

But there are very large areas where these advantages cannot be enjoyed, and where the peasant, to support himself and his family, relies on the local empirical system of agriculture, and upon the inherent capabilities of the soil. To this class undoubtedly belongs by far the greater part of the land under cultivation in the Hausa States. As the traveller pursues his journey, hour after hour, and day after day, it is land of this description which continually meets his eye, and which presents endless problems of interest to the student of agriculture.

The following description will give some idea of the method of cultivation most commonly followed:

Ridges are almost invariably thrown up at intervals

of about 3½ ft. These are made by turning, with a hand-hoe, two sods each 10 in. wide, face downwards, upon an intervening space of approximately 22 in., which forms the base of the ridge. A third stroke of the hoe is employed to deepen the furrow, the soil so removed being used to cap the ridge. This operation causes the surface weeds and humus rapidly to decay, and the resulting plant foods are in exactly the position where the roots of the young crop can turn them to the best possible account. At the same time the furrows, broken as they are by transverse banks at frequent intervals, not only catch the rain, but are in many cases of such a capacity as to be able to retain the water resulting from a heavy storm, and to impound it until it has had time to be entirely absorbed by the soil.

By leaving the base on which the ridge is formed uncultivated—a custom which may at first strike one as slovenly—an enormous economy of labour is effected, and a compact medium is secured, which nevertheless, owing to the extremely sandy nature of the soil, is at once penetrable to the roots of the plant and pervious to water. At the same time, since the site of the ridge one season generally becomes the furrow during the following season, the plants have the full advantage of 10 in. of cultivated soil, even though the depth of cultivation below mean level be only 5 in.

Subsequent cultivation consists in hoeing, the soil being each time thrown up towards the ridges. The value of this operation is fully appreciated by the Hausa, though the extent to which it is carried out varies here, as in every other country.

Here, as elsewhere, several crops are often grown simultaneously on the same land. So far as yield of food per acre is concerned, this practice has been justified in various parts of the world by actual experiment. No reliable figures are at present available to illustrate the wisdom or otherwise of the custom in Northern Nigeria, but observation would certainly tend to support it.

Scientifically it can be explained in that different crops avail themselves of different plant foods, and draw their

supplies from different layers of the soil in varying proportions. Further, they grow and ripen at different times, and consequently turn the soil to better account during the growing season than would be possible for any one crop singly. This is especially important with a sandy soil and tropical climate, which combine to cause a serious loss of nitrates.

Before attempting to answer the primary question as to whether the soils of Hausaland may be classed as fertile, it is necessary to have a clear idea of what is meant by "fertility."

Accepting the definition that the measure of a soil's fertility consists in its capacity for producing crops, then there are two distinct types of fertility, namely, that with which a soil is naturally endowed, as seen to advantage in the Nile Delta, and that induced by man, of which a garden soil or a farm improved by a good tenant may be taken as examples.

Now the agriculture of the Hausa States is typically "extensive," large areas rather than heavy yield per acre being relied on for crop production.

Whereas, under the system of intensive agriculture practised in England, land tends to become more and more fertile, and year by year to produce heavier crops, or in other words to improve in "condition," in Hausaland the reverse is the case. Here the land is cropped from four to eight seasons only in succession, and is then allowed to lie fallow until the recuperative processes of Nature enable it once more to produce profitable crops. Since, therefore, the Hausa makes little or no attempt to induce fertility, but prefers rather to draw upon the bounty of Nature, we need merely consider for the moment the natural fertility of his soil.

But again we are faced by the fact that "fertility" is only a comparative term. In order, however, to arrive at some conclusion in the matter, the grain-yielding capacity of unmanured land here may be compared with that of typical arable land in England as exemplified by the classic experiment at Rothamsted, where a wheat crop has been raised annually upon the same field without

manure since 1852, and where, in the year 1900, the yield per acre was still over 12 bushels (equal to 720 lb. of threshed corn). We know by repeated measurement that the yield of threshed corn in Hausaland falls very considerably below this figure before the field is allowed to lie fallow, which generally occurs within six years, and this in spite of the fact that cow peas and indigo (Leguminosæ) are almost invariably grown concurrently with the cereals, and that one year in the six is generally devoted to ground nuts (*Arachis hypogæa*), whereas at Rothamsted all Leguminosæ—even weeds—have been rigidly excluded.

So far then as it is practicable to challenge the claim of Hausaland to so abstract a distinction as fertility, the above considerations are presented as convincing.

There is still the second and far more interesting question of how such measure of fertility as does exist is maintained from generation to generation. What are the agencies tending to increase or destroy it? And can man step in and modify these agencies in such a way as to yield him a more ample harvest?

This at once leads to a consideration of the constitution of the soil and the needs of the plant.

The soil is essentially a medium of a certain chemical composition, with a certain physical constitution, and containing a certain quantity of water, and (in the case of all crop-producing soils) supporting an abundance of microorganisms. These latter are intimately connected with plant nutrition.

Amongst the foods acquired by the plant through its root, those which are found most generally to control the fertility of a soil are nitrogen, phosphates, and potash. Of these, a study of the crystalline rocks of the country, as well as of the indigenous flora of Hausaland, leads one to believe that the last-named is present in sufficient quantities for the needs of farm crops, while the proportion of phosphates is likely to vary considerably in different localities. The evidence, however, is convincing that the supply of nitrogen is almost invariably deficient.

These general deductions are borne out by an analysis

of arable soil from Kano, recently made at the Imperial Institute, which gave the following results:

		Soluble in hydrochloric acid.	Soluble in 1 per cent. solution of citric acid.	
		Per cent.	*Per cent.*	*lb. per acre.*
Lime	CaO .	0·02	—	·
Magnesia	MgO .	0·05	—	—
Potash	K_2O .	0·05	0·0097	309
Phosphoric acid	P_2O_5 .	0·01	0·0008	25
Ferric oxide	Fe_2O_3 .	0·88	—	—
Total nitrogen	N .	0·03	—	—

Before prescribing a remedy for this state of affairs its cause must first be ascertained.

It is generally believed that the original source of the nitrogen absorbed by plants is the air. This nitrogen is secured from the inexhaustible supply in the atmosphere either by the agency of micro-organisms existing in a state of symbiosis with the host plant, as in the case of Leguminosæ, or by bacteria such as Azotobacter which, by the energy derived from organic compounds existing in the soil, are enabled to fix the nitrogen of the air direct. Small quantities, also, are fixed as ammonia by electrical discharges in the atmosphere and are brought down to the soil by rain.

The nitrogen fixed by the two first-named processes subsequently contributes to the general fertility of the soil by the decomposition of the organic matter, and the breaking down of the nitrogenous matter into simpler amino-compounds, salts of ammonia, nitrites, and nitrates, by specific micro-organisms. It should be remembered, however, that this breaking-down process is not a "source" but merely the "channel" through which the two first-named processes are enabled to exercise to the full their essential functions.

Having reviewed the processes which Nature employs to enrich virgin soils with nitrogen, the means by which the Hausa contrives to impoverish them by raising his food crops may be considered. He waits until May comes, with a temperature generally ranging from 75° to 95° F. in the shade, with frequent warm showers, and then he cultivates his land. The soil has been exposed to a tropical sun for

six months previously without rain, which not improbably may have had the effect of greatly reducing the protozoa or amœboid bodies in the soil, which have in recent years been shown to prey upon the nitrifying bacteria.

The result of these conditions, greatly exaggerated by the low specific heat and extremely porous nature of the soil, is the rapid consumption of organic matter and the production of nitrates at an extraordinary speed. In this "hot-bed" the Hausa sows his seed, with the result that within ten days the whole country-side assumes the most beautiful dark green tint and everything grows at a remarkable rate.

This annual phenomenon constitutes the so-called "fertility" of Hausaland.

But in the meantime the soil, in spite of the legumes to be seen in almost every cultivation as an intercalary crop, is rapidly depleted of its nitrogen, not only in the form of crops removed from the land but also as drainage water, to which the floods of August and September owe their origin.

The work of destruction continues until the "Harmattan" in October brings it to a natural conclusion by arresting all plant growth, and gradually also bacterial action. Little restoration can take place in the dry season, and the following year, unless a leguminous crop is taken by way of rotation, the "whipping process" commences again.

But, it may be asked, why does not the Hausa make a wider use of leguminous crops, as is done in Europe, America, and Egypt? The reply is briefly that he merely grows what he needs and consumes what he grows. His staple food is corn, and he does not grow food expressly for his stock, as natural vegetation is available. He therefore has no need for large areas of legumes, and consequently does not grow them.

Having seen how the Hausa farmer destroys the natural fertility of his soil, and having considered Nature's two great processes for securing nitrogen from the air, there are two applications of these processes of special interest in Northern Nigeria which are worth noting.

Firstly there is the predominance of leguminous trees. Acacias abound. Among these may be mentioned *A. Seyal*, *A. albida*, *A. Sieberiana*, *A. Nilotica*, *A. Senegal*, and *A. campylacantha*. But over and above all must be mentioned the ubiquitous *Parkia filicoidea*, which more than any other is responsible for giving to the Hausa States their park-like appearance, and which provides food as well as shade for man and beast. But to say nothing of numerous other useful offices which this tree performs in the native economy, attention must be called to its importance as a great fertiliser, supplying as it does, by its annual fall of leaves, which cover the soil like bracken, not only a rich supply of nitrogen but also ash constituents, brought by its great ramifying roots from the sub-soil.

The second very interesting feature to which it is worth calling attention, in view of recent researches as to the action of sugar in supplying food for nitrogen-fixing bacteria of the Azotobacter group, is the heavy fall of "honey-dew" secreted by aphides on the leaves of *Sorghum vulgare*. So marked is this copious secretion that not only can honey bees be heard busily working in the ripening corn, but also the drippings of "sugar" often form a crust on the surface soil. It would be extremely interesting to ascertain exactly to what extent this deposit is of benefit to the soil flora.

Lastly, it remains to be seen how the Hausa can be induced to aid, rather than baffle, Nature in her untiring struggle to enrich his soil. One obvious means has recently been found. An ever-increasing demand for ground nuts exists in Europe, and by running railways into the heart of the sandy soil areas of Hausaland an unlimited local market for this source of oil can be created (the oil may possibly prove a great motive power and pioneer in the future development of Africa), which will at once bring wealth to the cultivator and fertility to his soil.

Already, indeed, this work has begun, for the arrival of the railway at Kano has within eighteen months given such a tremendous stimulus to ground-nut cultivation in the neighbourhood that the resources of the management are being taxed to the utmost to cope with the traffic. Every

available piece of land is being planted up with ground nuts, which yield here at the rate of about 1 ton per acre. What the fixation of atmospheric nitrogen will be it is impossible to say, but its influence on the fertility of the soil will, one would imagine, be at least equivalent in effect to that of a modern cyanamide installation of enormous dimensions.

Another promising field of work lies in the breeding of better stock, which will repay good feeding, and consequently demand of their owner the growth of leguminous forage crops. The growing of these "soil-builders" can be rendered practicable by gradually introducing the use of labour-saving implements and so increasing the area under cultivation.

The full achievement of these possibilities will take time, but their development will have an important influence on the productivity of the country as well as on the well-being of its people.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE CULTIVATION AND PREPARATION OF RICE

PART I

THERE are several species of the genus Oryza, the family of grasses to which the rice-plant belongs, but the species of greatest importance is *Oryza sativa*, Linn., the common or aquatic rice-plant, of which there are an immense number of cultivated varieties. The wild plant from which the cultivated forms have been derived has been found growing naturally in marshy places in Southern India and Indo-China, and in all probability this region is its original home. Other forms of wild rice, which as far as the structure of the spikelets is concerned might be considered conspecific with *O. sativa*, have been found in North Australia, Borneo, tropical Africa, and South

America. The Canadian wild rice (*Zizania aquatica*, Linn.) and the Manchurian "water-rice" (*Z. latifolia* Turcz.), are quite distinct from the true rices.

The cultivated rice plant is an annual with stems varying in height from 1 to 6 or more ft., furnished with tapering leaves 1 to 2 ft. in length, and upwards of 1 in. in width; the flowers are produced in one-flowered spikelets, in panicles 8 in. to 1 ft. in length, that are at first erect but become arched as the grain ripens; the two pales are persistent, forming the "husk" of the ripe grain, and in some varieties the lower pale is furnished with a stiff awn of considerable length; the grain is enclosed in, but does not adhere to, the persistent pales. The cultivated rices vary greatly in habit of growth and also in the size, shape, weight, colour, consistence, and properties of the grain. Rice, like wheat, will throw up a number of culms if the plants are not too crowded, a process known as "tillering."

Several attempts have been made by botanists to classify the numerous forms of cultivated rice; the most useful systems for practical purposes are those based on the cultural requirements of the plants and their periods of growth. The Japanese botanist, Kikkawa, who has had exceptional opportunities for studying the forms of rice cultivated in the East, has published a useful paper on their classification in the *Journ. of the College of Agric., Univ. of Tokyo* (1912, **3**, No. 2, p. 11). In this paper, the classification proposed groups the varieties according to their habit of growth and cultural requirements, and also according to the characters of the grain. A summary of the grouping used for the classification according to cultural requirements and habit of growth is as follows:

(A) *Aquatic or Lowland Rice.*
- (*a*) early; (*b*) medium; (*c*) late.
  - I. Ordinary Rice.
    - (*a*) tall; (*b*) medium; (*c*) short.
      - (1) awned; (2) awnless.
  - II. Special Rice.
    - (*a*) giant; (*b*) salt.

(B) *Upland or Hill Rice.*
- (*a*) early; (*b*) medium; (*c*) late.
- (*a*) tall; (*b*) medium; (*c*) short.
  - (1) awned; (2) awnless.

The points of distinction used for classifying the

varieties, including both aquatic and upland rices, according to the grain are:

(A) *Non-glutinous Rice.*
I. Slender-grained. II. Long-grained. III. Short-grained.
1. Large-grained. 2. Medium-grained. 3. Small-grained.
(*a*) Common coloured.
(A) Ordinary. (B) Scented.
(*b*) Specially coloured.

(B) *Glutinous Rice.*
I. Slender-grained. II. Long-grained. III. Short-grained.
1. Large-grained. 2. Medium-grained. 3. Small-grained.
(*a*) Common coloured. (*b*) Specially coloured.

The primary grouping into aquatic and upland varieties is recognised in most rice-growing countries, but Kikkawa points out that in Japan some of the so-called upland rices grow and yield better in flooded fields than in ordinary fields; on the other hand, there are some Indian lowland forms that only need flooding during the germinating period; hence it is impossible to draw a hard and fast line separating these two groups. It is probable, however, that the true upland rices are derived from distinct species that have their natural habitat in mountain regions, such as *Oryza granulata*, Nees, and *O. latifolia*, Desv.; but as the upland forms have no distinctive morphological characters their origin is somewhat difficult to account for. Watt considers they have descended from the variety of *O. sativa* known as *abuensis*, which occurs wild on Mount Abu, Rajputana.

The grouping of the varieties into early and late kinds is also a familiar classification for practical purposes in all rice-growing countries. Where climatic conditions are favourable, and the necessary water supply is available, it is possible to raise several crops during the year, and to suit the local conditions that prevail at different periods special varieties of rice have been evolved. Thus in some parts of India five distinct seasonal groups are recognised; they are:

	Sown.	Harvested.
1. "Aus" or early autumn rice .	April-May	July-September
2. "Aman" or winter rice . .	May	November
3. "Boro" (kharif) or autumn rice .	June-July	September-October
4. "Boro" (rabi) or spring rice .	October-November	May
5. "Raydra"	December	September-October

In Siam there are two seasonal groups, viz.:

	Sown.	Harvested.
1. "Khao bao" . .	January-February	May-June
2. "Khao nak" . .	June-July	December-January

In Japan the time of sowing varies with the district, and may differ according to variety, but in most cases all varieties in one district are sown at the same time. The early varieties ripen in from four to five and a half months, the medium varieties in from five to six months, and the late varieties in from five and a half to six and three-quarter months. In Burma the following groups of varieties are known: "Kaukkyi," which ripen in five to five and a half months, and are harvested in January; "Kauklab," ripening in four to four and a half months, and harvested in December; and "Kaukyin," which take only three months to ripen and are harvested in November. In most of the rice-producing countries similar groups of varieties are grown. The term "giant rice" is proposed by Kikkawa for certain forms that grow beyond the normal height of ordinary rice, which is usually about 3 ft., and seldom exceeds 6 ft. In Siam and certain parts of India the stems of "giant rice" have been known to reach a length of from 10 to 15 ft. As they seem to possess the property of growing taller as the water rises, these "giant rices" have their value in districts liable to flooding, and where the depth of the water cannot be controlled.

Fresh water is required for most cultivated rices, but there are a few varieties, known as "salt rices," that will grow in situations that are liable to be flooded with sea-water. Certain rices of the Bombay Presidency and of the Philippines belong to this category, and it would appear that some of the Egyptian varieties are also able to resist the action of salt in the soil, as rice is one of the crops recommended for cleansing salt land in Egypt.

The glutinous properties of some forms of rice grain have been observed from ancient times, and the grouping into glutinous and non-glutinous varieties is well understood. There are, however, few striking morphological characters to distinguish the plants that yield these two kinds of grain, except that the glutinous varieties are said

to produce more tender leaves and stems than the non-glutinous kinds. The grain of glutinous rice is readily distinguished, when ripe and well dried, owing to its opaque, chalky appearance, as against the wax-like, semi-translucent grain of the non-glutinous rice; when steamed the former becomes transparent and sticky. Rice obtained from the "Kaukyin" varieties of Burma is said to be so glutinous that it will not stand the boiling required by ordinary rice, and is used for making various kinds of sweetmeats. In China only 20 to 30 per cent. of the total amount of rice cultivated is glutinous. It is occasionally cooked and eaten as a change from ordinary rice, the common method of preparation being to roast the grain after it has been steamed to form a kind of "popped corn."

Hooper states (*Agric. Ledger*, 1908–9, No. 5, p. 75) that the glutinous property is probably dependent solely on the carbohydrate constituents of the grain. According to J. Shimoyama (quoted by Kikkawa, *loc. cit.*) the endosperm of glutinous rice contains only a small amount of common starch, with a small percentage of soluble starch and dextrin as well as some maltose. The grains of both glutinous and non-glutinous rices vary greatly in size, shape, and colour; in some cases only the outer skin is coloured, in others the grain is coloured throughout.

Climatic Conditions and Soil Requirements

Rice is naturally a tropical plant, but under cultivation it grows well in sub-tropical regions, although in such localities it requires a longer period for development. The principal rice-producing areas of the world are situated within a zone that extends as far as 45° north latitude in some parts of the Old World (*e.g.* valley of the Po river, Italy), but in the United States of North America is some 10° farther south. In the southern hemisphere, with a few exceptions, the zone does not extend far south of the Tropic of Capricorn. For its successful cultivation rice requires full exposure to bright sunshine, an average day temperature of above 70° F., with a warm night temperature and a heavy rainfall, or a supply of fresh water sufficient to inundate the soil during the period of growth. It is in this

last-named requirement that aquatic or swamp rice differs from all other cultivated cereals. The upland varieties of rice need no more soil moisture than ordinary cereal crops, provided the atmosphere is humid ; but these varieties are grown on a much smaller scale than are the aquatic kinds. Within the zone above mentioned, whenever fresh water can be economically applied to the land, rice can usually be grown as a profitable crop. For the most part, the water necessary for flooding the fields is supplied and controlled by artificial systems of irrigation, and only in certain districts, such as, for instance, the delta zone in Burma and parts of Siam, is the rainfall sufficient to inundate the fields without the help of artificial irrigation. In Eastern countries there are numerous contrivances of a primitive nature, usually involving a large amount of manual labour, for raising the water for irrigating rice fields; but in the United States of North America, where labour is expensive, and rice is cultivated by modern methods, a large part of the water supply is obtained from Artesian wells, and is raised to the necessary level by means of power-driven pumps.

In respect of soil, rice shows great adaptability, provided inundation is possible during the period of growth. The soil most generally in favour is a rich clay-loam, overlying a subsoil of stiff clay, as such a soil will retain surface water even when situated at a considerable altitude. Rice can, however, be grown on a variety of soils of a lighter character if they are sufficiently low-lying to admit of being flooded and of retaining surface water. Although flooded fields are essential to the growth of lowland rice, good drainage is also necessary, as the complete withdrawal of the water prior to the ripening period provides the conditions most favourable to the proper maturing of the crop. Good drainage also allows of the more thorough cultivation of the soil and permits of its becoming sufficiently firm to support the heavy machinery that under modern methods of rice cultivation is now employed for harvesting the crop. Moreover, where the land is sufficiently drained, crop rotation can be practised, to the great benefit of the rice. In Japan, for example, naked barley and wheat are grown after

rice as cold-season crops, whilst in Java rice is grown in rotation with maize, ground nuts, soy beans and other legumes, capsicums, sweet potatoes, millets, and tobacco (cf. this BULLETIN, 1912, **10**, 257). If possible, the land chosen for rice culture should be level, with sufficient slope to admit of ready drainage. On such land it is possible to maintain a fairly uniform depth of surface water, and this conduces to the regular maturing of the crop. Land of uneven contour requires more elaborate banking to form level plots or fields on which surface water will stand at an even depth, and this naturally involves more labour and adds to the cost of production.

Seed Selection

It is important that the grain intended for sowing should be carefully selected with a view to securing seed of high germinative power, true to type and free from red grains. Light grains, which usually fail to germinate, may be eliminated from grains intended for sowing by winnowing or, more effectively, by floating off in salt water; the latter being the method commonly practised in Japan. To keep the grain true to type it is advisable to collect separately, previous to harvest, the finest heads from the best yielding plants of the particular variety found to be the best suited to the locality, and to reserve the grain obtained from these for sowing purposes. The crop obtained from seeds so selected should be subjected to a similar process of selection during subsequent harvests until the type has become "fixed." The mixing of seed intended for sowing is strongly deprecated, as it is probably due to this practice and to the absence of any selective methods that the quality of rice has undergone the deterioration which is said to have taken place during recent years in some rice-producing countries. A recent study of the varieties of rice grown in Lower Bengal has shown that although rice is normally self-fertilised, cross-fertilisation may occasionally take place between adjacent plants through the agency of the wind. So long as all the plants in a plot are true to type, there is no risk of contamination from cross-fertilisation, but should the seed used for sowing be mixed, it would result in

reducing a variety to a number of splitting types in a few years (cf. *Mem. Dept. Agric. India*, *Bot. Ser.* 1913, **6**, No. 1). The elimination of red grains is important, if the crop is intended for export, as the presence of red grains in samples of milled "white" rice lowers the commercial value of the latter considerably, and there are no methods of milling by which red grains can be separated from white when the two kinds are mixed together. For milling purposes the grain should be regular in size, large and heavy, long and cylindrical in shape, as such kinds are less liable to get broken during the milling processes than are flat or "turtle-grained" varieties. A small embryo or "germ," a thin, awnless husk, and a hard, translucent kernel capable of taking a high polish are other desirable qualities. The nitrogenous qualities and weight of the grain may be improved by cultivation, by the addition of suitable manures to the soil, or by growing the grain on virgin land. The breaking of the grain is frequently due to careless harvesting, and is not in all cases an inherent defect in the variety of rice.

An increased yield may sometimes be obtained by sowing seed from some other locality. Before this is done on a large scale, however, it is advisable to test the new variety by growing on an experimental plot, otherwise loss may result. Obviously a variety requiring six months to mature cannot succeed where the climatic conditions and water supply are only suitable for a variety ripening in from three to four months, and there are other less striking peculiarities that require to be ascertained experimentally before changing seed on a large scale.

Manures

Owing to the saturated condition of the soil essential to the growth of lowland rice, the selection of a suitable manure for this crop is a matter of some difficulty. Where the land is naturally flooded or, in some cases, where river water is used for irrigation, a layer of silt is deposited by the water standing on the soil, which is to a varying extent enriched thereby, and little manuring is required. In common with other cereal crops, rice withdraws nitrogen,

phosphoric acid, and potash from the soil, and these constituents require to be present in manures intended to restore fertility to rice lands. Very little systematic manuring is done in rice-producing countries, but recent experiments in India and elsewhere have shown that the yield can be increased considerably by the judicious use of suitable manures. On the other hand, if the crop is unduly stimulated it is liable to produce a rank growth of straw, accompanied by a poor yield of grain. Experiments on the Central Farms, Coimbatore, have shown that bulky organic manures applied to rice fields give better results than manures of similar value but containing little organic matter. In Oriental countries where manuring is practised, the manures most in favour for rice are green manures, oil-cake, farmyard manure, night soil, and fish manure, all of which contain a considerable amount of organic matter that on decomposing serves to increase the amount of humus in the soil and to improve its physical properties. Nitrates are unsuitable as rice manures, as they are soluble in water and liable to be washed away, whereas compounds that yield ammonia in rice lands are valuable, as the rice plant readily absorbs ammonia, which, although soluble in water, is retained by the soil to a much greater extent than are nitrates. Recent experiments with cyanamide, which yields ammonia in rice soils, have given promising results, and it may possibly prove useful for mixing with low-grade poonac or other organic manures deficient in nitrogen.

Where rotation of crops is practicable, organic manures are best applied to the crops preceding rice, but if this is not possible it is advisable to apply them to the fields about a month before transplanting the rice, as if applied just previous to transplanting the products of decomposition may prove detrimental to the young plants.

The following leguminous plants have given good results as green manures in India: "daincha" (*Sesbania aculeata*), sunn-hemp (*Crotalaria juncea*), wild indigo (*Tephrosia purpurea*), and green gram (*Phaseolus Mungo*). Under favourable conditions daincha will grow to a height of 8 ft., and 1 acre will yield sufficient material to manure 4 acres of rice land. The other plants men-

tioned are of lower growth, and are best grown on the land and ploughed in. In Japan the most favoured green manures for rice are the soy bean (*Glycine hispida*) and "genge" (*Astragalus sinicus*). These and other leguminous plants add nitrogen to the soil, and on decomposition return to the soil the phosphoric acid and potash they had absorbed. Even more valuable as green manures are green leaves collected in forests or waste places, as they add phosphoric acid and potash to the soil, in addition to nitrogen and humus. The manures above mentioned are chiefly valuable for supplying nitrogen to the soil, but they may be rendered more effective by the addition of phosphatic manures. Of these the most suitable for rice are superphosphate and bone-meal, both of which give quick results in rice soils. It is seldom necessary to add potash manures to rice land, especially if the stubble or straw is burned on the soil or turned in when ploughing is done. Where soils are found to be actually deficient in potash, it may be added in the form of wood-ashes or potassium sulphate.

The kind of manure applied will naturally depend to a large extent on local circumstances as regards availability and cost of transport, and the peculiarities of the particular soil to be dealt with. As a guide to mixtures that have given good results when used experimentally, the following may be quoted: A leguminous green-manure crop plus 112 lb. per acre of superphosphate; bone-meal 240 lb. plus saltpetre (nitrate of soda) 60 lb. per acre; fish manure 560 lb. per acre, plus sulphate of potash or wood-ashes on soils deficient in potash; castor-oil cake 400 lb. per acre, either alone or with the addition of superphosphate; green leaves alone 4,000 lb. per acre.

Oriental Methods of Rice Cultivation

The general methods of cultivating rice are the same in nearly all the rice-growing countries of the East, although they differ in detail according to local circumstances. In eastern and south-eastern Asia the first condition of rice culture, in its early stages, is the utilisation of the rainy season which follows the change of monsoon in spring.

Where the rainfall is not sufficient to supply the requisite amount of moisture, artificial irrigation has to be resorted to. The native practice is to utilise any stream or river that may be available for this purpose, and, where necessary, canals are formed to convey the water to the rice fields. Frequently a stream at the head of a valley or on a hill-side is utilised for this purpose, the hill-side or sloping valley being terraced or banked up in order to form level plots that will retain surface water. Terraced hill-sides are characteristic features of most of the rice-growing countries of the East; they are usually very ancient, and represent a large expenditure of human labour. In such situations the rice fields usually consist of small plots of one-tenth to one-eighth of an acre or less in extent, of irregular outline, each surrounded by a mud dyke or "bund" to retain the water. The first cost of putting up these bunds is heavy, but when once formed they last for many years with occasional repairs. The cultivation of such small plots entails a large amount of manual labour, as from their situation and form it is impossible to employ machinery, except the primitive native ploughs and levelling implements. On low-lying, level lands the fields are larger in extent and more economical to cultivate.

Seed-bed.—As most of the aquatic or swamp rice is transplanted, cultural operations commence with the seed-bed, or nursery, where the young plants are raised. To form the nursery, the best field, or portion of a field, possessed by the cultivator is usually selected, situated where it can be readily irrigated. Usually from about one-twentieth to one-tenth of the area to be planted is required to form the seed-bed.

The soil of the selected site is first softened by rain or by being flooded with water, and is then ploughed with a native plough several times in cross directions, or turned with the mamoti and puddled by treading, so that the surface soil to a depth of about 3 in. is reduced to a soft mud, on which the seed is sown broadcast. The soil of the nursery is usually enriched by the application of manure before ploughing. In Japan a favourite manure

for this purpose is canal mud or ashes and night soil; in Burma it consists either of cow-dung or paddy husks applied to the soil about a month before cultivation commences. In Western India the seed-bed is prepared by the "rab" system. This consists in burning cow-dung, branches of trees and shrubs, grass and other combustible material on the soil, after which the seed is sown in the ashes and ploughed in as soon as the first rains fall. The seedlings from beds prepared by the rab process are much stronger, and succeed better when transplanted than those raised in the ordinary way. The efficiency of this process is due to two causes—(1) the heating of the soil and (2) the manurial effect of the ash and other material left on the land after burning (cf. *Mem. Dept. Agric. India, Chem. Ser.*, 1912, **2**, No. 3).

The seed-bed is flooded to a depth of about 3 in., and is kept saturated by artificial irrigation should the rains not be sufficient. When the rains are late, and water for irrigating the seed-bed is not available, the seed is sometimes sprouted before being sown in order to expedite growth. This is effected by soaking the seed in water for about twenty-four hours, and then spreading it on bamboo trays shaded from the sun by leaves. Germination takes place in a few days, and it is then ready for sowing. Care is required in sowing sprouted seed, as the delicate shoots are liable to receive injury from handling.

In the Laguna Province of the Philippines the natives spread the seed of early varieties of rice, after being soaked, on banana leaves, which are then sunk into the soft mud of the seed-bed only just sufficiently deep to cover the seeds. In from twelve to fifteen days from sowing the seedlings are 10 cm. (4 in.) high, and the roots have formed a thick mat over the banana leaves, but have not penetrated to the soil below. They are readily removed from the seed-bed without injury to the roots, and are transplanted when only from ten to fifteen days old.

In Java, soil of only average fertility is chosen for the seed-bed, as experience has shown that seedlings from rich beds receive a check, and grow less satisfactorily after being tran splanted to a less fertile soil. Great importance

is also attached to what are known as "dry" seed-beds, which, in the absence of rain, are kept only just sufficiently moist to maintain a slow growth of the seedlings. In such beds seedlings may remain for as long as a hundred days, and can then be transplanted without harm. In districts dependent entirely upon rainfall, transplanting has often to be delayed for want of rain, and in such localities "dry" seed-beds are particularly valuable. Before lifting seedlings from such beds a thorough soaking of the soil is, of course, necessary, so that the roots may be removed from the soil without receiving injury.

Preparation of the Soil.—During the time the seed is germinating in the seed-beds and the young plants are becoming sufficiently large to transplant, the preparation of the rice fields takes place. The soil is first softened by rain, or by irrigation if the rains have not commenced, and then subjected to shallow ploughing. Usually a rank growth of grass and weeds appears as soon as the rains commence, and this has to be cut down before ploughing takes place. A hand machine, constructed on the principle of the ordinary lawn-mower, has recently been introduced into Burma for this purpose. Several ploughings in different directions are given, and the field is then allowed to stand for a week or so to become dry. It is then flooded, and a further ploughing and harrowing under water takes place to produce a soft puddle, into which the young rice plants can be readily inserted. Motors are now being used for ploughing in Siam. The motors are oil-driven traction engines which have been adapted for ploughing, and are found to work well and give little trouble. The best motors, of 15 horse-power, are employed to pull heavy disk harrows, and are capable of ploughing 2½ acres of stiff clay land per day, to a depth of about 4 in. Smaller motors of 5 horse-power are used to pull two-furrow share ploughs. The cost of employing these machines is found to be much cheaper than bullock ploughing, and, it is anticipated, will be further reduced when specially constructed motors become available.

Transplanting.—In from thirty to forty days from the time of sowing, the seedlings are ready to be transferred

from the seed-bed to the fields. They are then from 1 to 1½ ft. high. They are lifted from the seed-bed and made up into bundles, each comprising about 1,000 seedlings, which are conveyed to the fields and deposited at intervals convenient for the workers. If strong and well grown, a portion of the upper leaves is removed from the young plants, which has the effect of limiting transpiration until new roots have formed in the soil. The planting is largely done by women, who walk backwards and insert the plants, usually three to five or more together, in the soft soil, at a distance apart of from 6 to 8 in. Recent experiments in Bengal and in Japan have shown that as good results are obtained from planting the seedlings singly as from planting in clumps. This fact is important, as it follows that a great saving in seed would be effected were single planting generally adopted. Single planting would, however, necessitate much thinner sowing in the seed-bed, to enable the plants to be separated without injury to the roots, as under the present system of raising seedlings the roots are usually matted together.

Broadcast sowing is sometimes adopted in lieu of the transplanting process, especially in cases where the rains are late and where irrigation by artificial means is not practicable. This is a wasteful method, and does not give such good results as transplanting, but it entails less labour. Some of the seasonal rice crops of India, which follow other crops, are broadcasted. In this latter case the land is moistened and ploughed several times, the seed is sown in the moist soil, and sufficient water is applied to cause the seed to germinate, after which the soil is kept moist by irrigation during the growing season.

Irrigation.—From the time the rice is transplanted up to about a fortnight or three weeks before harvest the soil of the rice fields is kept submerged. The amount of water in the fields is carefully regulated, more or less being admitted according as the weather is warm or cool, dry or humid, in order to maintain a certain temperature around the plants. The water is withdrawn from the fields before ripening takes place, otherwise the grain does not acquire the right degree of hardness, and is frequently changed

during the growing season in order to prevent stagnation and to check insect pests.

Weeding.—Weeds are usually troublesome in rice fields and require attention throughout the growing season, especially during the early stages. Hand-weeding is usually practised, and where broadcast sowing has been adopted this is the only method, but when planted in rows, hoes are sometimes employed. The water is usually wholly or partly withdrawn during the weeding process, and this checks the further development of young and succulent weeds which are allowed to remain between the rice plants after being pulled up, but the tougher weeds and grasses are usually removed from the fields and heaped on the banks to decay.

Harvesting.—The water supply is gradually diminished after flowering and is stopped altogether when full growth has been attained and the stems begin to lose their green colour. In Burma, before the rice is cut, the stems are turned in one direction by means of a long bamboo pole, and as the sickle is the principal implement employed for reaping the rice crop, this greatly facilitates harvesting operations.

When harvesting is done with the sickle, the straw is usually cut about the middle, so that a long stubble is left in the field. The heads of rice are tied up into small bundles which are placed on the stubble to "cure," and in about ten days these are ready for thrashing. If circumstances prevent the crop being thrashed at once, it is made up into small stacks. In some countries (Java, for instance) the ears are cut separately with a small knife and tied into bunches which are removed from the field to a favourable situation for drying before being thrashed. Thrashing is usually done by treading out with bullocks, by flailing or by beating the heads on a sloping plank of wood. The dust and other refuse is separated from the grain by primitive methods of winnowing.

Methods of Cultivation in the United States

In the United States of North America, rice cultivation is limited to the South Atlantic and Gulf States, where in

some districts it is the principal cereal crop. Since its introduction in 1694 rice has been cultivated on an increasingly large scale until in 1912 some 723,000 acres of rice were harvested and the production amounted to 25,054,000 bushels. The principal producing States are Louisiana, Texas, and Arkansas, the first-named being the most important. The great development of rice culture in Louisiana is largely due to the opening up of prairie land in the south-west part of the State, and to the adoption of a system of irrigation and culture which has made it possible to utilise modern machinery for the crop. The principal varieties of lowland rice cultivated are, the "gold seed" of the Carolinas, so called from the colour of the husk when ripe; the Honduras and Japan varieties. The "gold seed" variety takes high rank amongst cultivated rices of the world for quality of grain and for yield. The Honduras variety, originally introduced from Mexico, is similar in form of grain and habit of growth to the "gold seed" variety, but the quality is not so good. The Japan varieties were introduced on account of their superior milling qualities, one of them, known as "kiushu," yielding from 90 to 95 per cent. of "head-rice" on milling as against an average of about 40 per cent. by the Honduras and Carolina varieties.

Soils.—There are four principal kinds of rice land in the United States: they are (1) *delta lands* situated sufficiently remote from the sea to be free from flooding by salt water; (2) *inland marshes*, that can be conveniently drained and economically irrigated; (3) *alluvial lands* bordering fresh-water rivers; and (4) *prairie lands*, practically level areas that can be converted into rice lands with comparatively little expense.

The type of soil most favoured in the United States is a rich clay-loam, containing about 50 per cent. of clay. The rich drift soils of Louisiana and Texas prairies have a clay subsoil that is retentive of the water essential to the rice crop, and some of these soils are so stiff that they cannot be ploughed until softened by flooding. When properly drained they admit of the complete withdrawal of the surface water for ripening the crop, after which they

become sufficiently firm to allow of the use of a team of horses and heavy machines for harvesting. Alluvial lands, such as those along the Mississippi river in Louisiana, which have no hard, compact subsoil, cannot be drained in the same way and will not admit of the use of heavy machinery.

Gravelly and sandy soils have not, as a rule, been found suitable for the rice crop, as their physical properties will not allow them to retain the necessary amount of surface water; peaty soils have also been found unsuitable.

Preparation of the Soil.—This consists in spring ploughing shortly before planting time. Shallow ploughing to a depth of not more than 3 in. is practised by some growers on the grounds that the rice plant is surface-rooting and therefore does not require a deep-rooting medium, and also that deep ploughing renders the soil too porous. Deeper ploughing is, however, practised in many cases with good results. Where the subsoil is alkaline, deep ploughing is done in the autumn, so that harmful salts are washed away from the surface by the winter rains. The surface soil is brought to a good state of tilth after ploughing by the use of the disk harrow and by rolling. Good drainage is provided by means of open ditches, which in all cases are made deeper than the furrows, and the main drains are at least 3 ft. deep.

Sowing.—In most cases sowing is done by April 20, but the season varies according to locality, and may be as late as the middle of May or as early as the middle of March. It usually takes place as early as possible after the spring ploughing is completed. The amount sown per acre varies from 55–80 lb., according to the variety and method of sowing. The grain is sown either broadcast or in drills, the latter method giving the best results. After sowing the land is rolled and harrowed, and sufficient water is admitted from the irrigation supply to saturate the soil and ensure the germination of the seed. In the event of the soil being sufficiently moist to effect germination, the irrigation at this period is omitted. As in the East, the seed is sometimes sprouted by soaking it in water before sowing—a practise not recommended as, unless the soil in

which sprouted seed is sown is sufficiently moist to continue the growth, failure frequently results.

Flooding.—The practice varies considerably in different localities and is naturally influenced by the rainfall. Generally it is as follows: water is admitted to the fields as soon as the seedlings are a few inches above ground, and the depth of the standing water is increased as rapidly as growth permits until it is sufficient to destroy weeds. As far as possible a uniform depth over the whole field is maintained, as this conduces to the uniform maturing of the crop, and there is a regular intake and overflow of water in order to prevent stagnation. Water is frequently kept on the fields at a greater depth than is essential for the welfare of the rice crop in order to keep down weeds, but it has been found that "tillering" is greatly encouraged, and the yield thereby largely increased, by keeping the soil saturated with water but not allowing sufficient to stand on the surface until after the plants have fully "tillered."

In South Carolina the practice above described is somewhat modified. The sowing is made in well pulverised soil in trenches 12 in. apart and from 2 to 3 in. deep, opened by 4 in. hoes at right-angles to the drains. The grain is usually covered with soil, but in some cases the seed is dipped in clayed water before sowing, and is left uncovered, sufficient clay adhering to prevent it floating away. The water is admitted to the fields as soon as sowing is completed, and is allowed to stand for from four to six days until the grain has sprouted, when it is withdrawn. A second watering is given when the blade is a few inches high, and this is also withdrawn. A third watering is given after the seedlings have formed two leaves; at first the water is allowed to cover the plants completely, being generally from 10 to 12 in. deep, but this depth is reduced until it stands at about 6 in., at which it is kept for from 20 to 30 days, when it is withdrawn and the fields allowed to become dry. As soon as the soil is in a suitable condition it is hoed and weeds removed, and after the hoeing it remains without irrigation until "jointing" commences. A second hoeing is then given, after which water is again let on and is allowed to remain until about eight

days before harvest, being changed at least once a week to prevent stagnation.

Harvesting.—Rice is cut when the straw has just commenced to turn yellow, and is not allowed to stand until the stems have turned yellow to the top. Where fields are of a sufficiently large area and the soil of the requisite firmness to admit of their use, modern reaping machines or self-binders are employed to harvest the crop. Where the use of machines is not practicable the sickle is usually employed.

The straw is cut at about 6 to 12 in. from the ground, and the heads of rice are laid on the stubble to prevent contact with the wet soil. After remaining for a day to "cure" they are made up into bundles and stood in small stacks or "shocks." The "shocking" is done on dry ground, and care is taken to prevent exposure of the heads of rice to sun or rain by capping the shock with bundles, the heads of which are placed on the north side. Exposure to sun and rain is held responsible for sun-cracked kernels which, when present in a sample, greatly reduce its milling qualities and consequently its market value. Judgment is required to determine when the "curing" is complete, but in favourable weather a period of from 10 to 12 days after cutting suffices to harden the grain and dry the straw. Stacking is sometimes practised, but is not considered essential, and the grain is usually thrashed after being dried in the shock.

Thrashing.—This is now largely done by the use of the steam thrasher, as in the case of other cereals. Care is essential, in dealing with rice, to prevent breakage of the grain. Before being put up into sacks the grain is spread upon a floor and dried, as if sacked whilst damp the colour of the grain and its milling qualities deteriorate.

The average yield is from 8 to 12 barrels = 1,296 to 1,944 lb. of "rough rice" per acre, but on good lands properly managed the yield may be much higher, as on the lowlands of the Mississippi, where 30 barrels (= 4,860 lb.) per acre have been recorded.

The Cultivation of Upland or Hill Rice

As already pointed out, the upland and lowland forms of cultivated rice tend to merge into each other, and no sharp line of distinction can be drawn between them (see p. 636); the extreme forms of each kind are, however, quite distinct so far as cultural requirements are concerned, and whilst standing surface water is essential to the development of typical lowland rice it is unnecessary and even harmful to the extreme forms of upland rice. The cultivation of the latter is confined chiefly to hilly districts which cannot be artificially irrigated, and which in consequence are unsuited to lowland rice. Comparatively little cultivation is required, transplanting being unnecessary, and the natural rainfall affords the requisite amount of moisture.

Usually only a short period is required to mature the crop, the exact length of time necessary depending on the particular variety of rice grown and, to a large extent, on the duration of the rainy season.

The crop is therefore one which can be grown as a catch-crop on new plantations of perennial plants, or in rotation with other crops, and is worthy of more attention than it at present receives, especially in districts where a local demand for rice exists.

The success of the crop depends chiefly on the thorough preparation of the land, as this not only destroys weeds, but produces a fine surface tilth which serves as a suitable seed-bed for the grain and also tends to check the evaporation of soil-moisture. Soils of a lighter character than those required by lowland rice are preferable, and if it be virgin land a shallow ploughing is the only preparation required, but if the land has been cropped for several years deeper ploughing is essential in order to provide a more extensive rooting medium. As the seed is sown on the field and not on a seed-bed, it is important that grain of high germinative power should be selected for sowing, otherwise the stand will be thin and the crop proportionately scanty. For this reason it is advisable to test the vitality of the grain intended for planting, and to regulate

the thickness of the sowing according as the percentage of germinated seeds is high or low.

The cultivation of upland rice is carried on by the natives in nearly all rice-growing countries, but on a much smaller scale than in the case of lowland rice. Forest clearings are usually planted with this crop and abandoned after the first harvest, but as this is a wasteful system, destructive to the forests, it is now discouraged in most countries, and in some cases it is forbidden. The native methods of cultivation as practised in the Philippine Islands are described in the *Philippine Agric. Review* (1910, **3**, 632), and these may be taken as typical of the general practice. Two methods are practised in the Philippines known locally as the "caiñgin" and the "sábog" methods. The caiñgin method consists in clearing a portion of the forest of shrubs and small trees and burning them on the ground, prior to the rainy season, leaving the stumps of larger trees standing. The area thus cleared is planted at the commencement of the rainy season. The planting holes are made by men who place themselves side by side about 3 ft. apart and walk backwards, and, by means of pointed sticks 1 to 1½ in. in diameter, make shallow holes in the ground, from 4 to 8 in. apart, to receive the seed. The seed is sown by women or children, who walk facing the men, and place from 4 to 20 grains in each hole. From 4 to 7 grains, in holes 6 in. apart, usually suffice. The right hand is used for handling the grain, and with the left the holes are filled in with soil. In some cases the filling in is done by a third party of workers who follow the sowers and cover the seed by brushing soil into the holes.

By the sábog method the ground is ploughed once during the dry season, and again at the commencement of the rainy season, after which it is harrowed and the seed sown broadcast. A light harrowing is given after sowing, in order to cover the seed. Occasionally the seed is sown in drills instead of broadcast, in which case the sower follows the plough and places from 5 to 20 grains at intervals of from 4 to 8 in. along the furrow, covering them with soil by the foot, or the seed may be evenly

distributed along the furrows instead of in "hills," and covered by lightly harrowing the soil.

The rate of seeding is about 58 lb. per acre. The average yield is usually not more than half that from transplanted lowland rice, but on virgin lands, if the rains are favourable, heavier yields are frequently obtained.

During the years 1909 and 1910 the Philippine Islands Bureau of Agriculture made trials of some 458 native varieties of upland rice. Of this number only twenty-five are recommended for general planting. These are non-bearded kinds with white, non-glutinous grains; the length of time they required to attain maturity varied from 126 to 141 days, and the yield from 2,378 to 4,064 lb. per acre. In these trials the average yield was higher than for lowland varieties, but the trials covered a period of only two years, and both seasons were favourable to the crops (cf. *Bulletin* No. 22, 1912, *Philippine Islands Bureau of Agriculture*).

Upland rice has been successfully grown in the Logan district of Queensland, with a rainfall of between 20 and 30 in. during the growing season. The variety found best adapted to this locality is known as "White Java." This grows to a height of from 4 to 6 ft., and produces good crops of fairly plump grain, of good length and quality. The land is prepared as for an ordinary cereal crop, by ploughing and harrowing, to produce a fine surface tilth. The method of planting found to give the best results consists in sowing with an automatic seeder, in drills 2 ft. 6 in. to 3 ft. apart, with a spacing of 10 to 12 in. in the rows. The method requires 35 to 40 lb. of seed per acre as against about 60 lb. for broadcast sowing. The wide spacing between the rows permits of the use of the hoe or cultivator to remove weeds during the early stages of growth; it also encourages "tillering," and as many as thirty or forty heads of grain have been obtained from a single seed.

(To be continued.)

COTTON CULTIVATION IN NORTHERN NIGERIA

An account of the cotton industry of Northern Nigeria was published recently in this Bulletin (1913, **11**, 70), together with the results of examination at the Imperial Institute of samples of cotton grown in the Protectorate. Further information on this subject has been made known by the Director of Agriculture in the form of a Report on Cotton Cultivation in Northern Nigeria for the half-year ending December 31, 1912. As this Report is of considerable interest, it has been considered desirable to summarise it in this Bulletin.

The period under review practically comprises the cotton-growing season of Northern Nigeria, very little seed being sown before the former date, and practically no growth taking place after the latter, though the maturing of the bolls may continue some six weeks longer under favourable conditions. In spite of this, however, it would be wrong to suppose that the weather prior to July 1 has little or no influence on the cotton crop, for it is upon the earlier rains that the cereal crops (chiefly guinea corn and millet) depend for a satisfactory start, and not until the peasant sees the success of his staple food crops assured can he afford to expend labour on cotton.

In considering cotton production in Northern Nigeria, it must never be forgotten that the greater part of the Protectorate is faced with the problem of an annual drought of about five months' duration, extending as a rule from November to March; during the remaining seven months the food supplies of the year have to be raised, and the law of self-preservation naturally makes this the work of prime importance. This being so, it is difficult to see how cotton cultivation can ever occupy anything but a position of quite secondary importance.

The present season is a case in point. Over considerable areas the earlier rains were later and lighter than usual, with the result that agricultural operations were unduly delayed. Fortunately the later rains were generally plentiful, work went on apace, and the con-

sequence was that corn crops generally were well up to the average.

The same remarks apply to cotton which was sown during the first half of July. This unfortunately was seldom accomplished, however, large areas being sown in August; some plots in the neighbourhood of Zaria did not even receive their seed before the third week in September. One of these last-named plots was visited, and, as might be anticipated, in view of the fact that rain does not generally fall in this locality later than October, it was found that the plants had withered when some few inches high, not producing even a flower. Every gradation exists, from late-sown plots, such as the one described, up to the earliest sown, which present in most cases a very creditable appearance.

The native, of course, understands quite well that the later-sown cotton will not yield so heavily as that sown at an earlier date, but, as previously pointed out, the cultivator can but wait on the weather, and live in hopes that the rains may last long enough to give him at least some return for his labour.

From what has been said already it is clear therefore that, at any rate so far as the Northern Provinces are concerned, "early maturity" is a most important factor in the selection of a variety for general cultivation.

The fact that cotton has been cultivated by the natives of Northern Nigeria from time immemorial has often been quoted as going to prove that the Protectorate is admirably adapted by nature for cotton production, but this line of argument is by no means convincing. Numerous instances exist of commodities being produced in countries ill-adapted for their growth. The question appears to be merely one of supply and demand. In Nigeria a limited demand for raw cotton has existed for centuries at prices bearing little or no relation to those of the European market, the value of cotton at Kano having probably often been twice as great as at Liverpool, and cotton has been grown to meet this local demand.

There is every reason to hope that, since the British Cotton Growing Association has now created an unlimited

demand for raw cotton in Nigeria, the country may respond by increased production, but any such production will be achieved, not with the assistance of a fertile soil (see p. 626), but in spite of the generally prevailing very light sandy loam, which is incapable for the most part of producing heavy cotton crops without manure.

The Director of Agriculture spent six months touring in the principal cotton-producing districts of Zaria and also of Ilorin, studying, among other things, the presumably indigenous varieties of cotton. This inquiry has led to extremely interesting results, establishing the fact that there are at least four distinct species at present in cultivation. These include:

Gossypium peruvianum. Ilorin cotton with green stem and leaf veins. Zaria cotton with red stem and leaf veins.

G. punctatum. Kano annual cotton.

G. obtusifolium, Roxb. var. *africana.* Kano perennial.

G. arboreum var. *sanguinea.* Tree cotton, rather uncommon, with dark crimson flower, grown in compounds in villages, and often used for native medicine; observed in Ilorin, Bida, and Soba.

G. peruvianum is, speaking generally, by far the commonest type, and probably 95 per cent. of the Nigerian cotton handled by the British Cotton Growing Association is derived from this species. The Ilorin variety of this species, characterised by green leaf veins, required, as would be expected, a longer season to reach maturity than the Zaria variety, which belongs to a drier zone. Neither of these, however, matures so rapidly as *G. punctatum*, which is grown in the still drier region of Kano as an annual with great success.

G. obtusifolium is grown as a perennial, and is adapted to climates with a rainfall so scanty as to render the growth of an annual cotton too hazardous an undertaking. The plant was observed in the region of Lake Rudolph, and there is reason to believe that it is to be found throughout the drier parts of the southern Sudan.

During the past season, plots of the Zaria variety of *G. peruvianum* were grown alongside the Kano cotton (*G. punctatum*). Though both plots were sown on the

same day, namely July 3, the picking of the former had not been begun on December 31, whereas the harvesting of the latter was practically complete on that date. In view of this evidence, the Director of Agriculture would be strongly opposed to distributing seed from the Zaria ginnery in Kano Province during the coming season, except perhaps on the southern border adjoining Zaria, where the Zaria variety of cotton is commonly cultivated.

The Director of Agriculture summarises his impressions as to the present position of cotton cultivation in Northern Nigeria as follows:

"In the first place, I am very favourably impressed by the area devoted to cotton and by the knowledge of the crop which the natives already possess. The general adoption of ridge cultivation and the time devoted to hand-hoeing are almost comparable with Egyptian methods. These remarks, however, do not apply in the Ilorin district, where cotton is almost universally grown on mounds in conjunction with yams, and often indeed with maize as well.

"The dry climate, particularly in the north, permits of the staple being gathered in first-rate condition, remarkably free from stained and immature cotton. Unfortunately, the tendency is to leave the cotton on the plants so long that it often falls to the ground, thus picking up particles of earth and other foreign matter, which deteriorate the grade.

"What strikes me perhaps more than anything else is the inferiority of the native cotton (*G. peruvianum*) from a fruiting point of view. The plants produce an abundance of wood, carrying their bolls (unlike *G. punctatum*) almost entirely on the secondary branches. They bear bolls very sparingly, and those which are borne are small and frequently abortive. The bolls are, like the Mitafifi of Egypt, almost invariably three-locked, and the lint also possesses the characteristic creamy colour of that variety, though the intensity of the tint varies considerably in the cotton from different plants, as does the lint, which is generally short and coarse.

"One of the commonest and most obvious errors in cultivation is the leaving of two, three, or even a dozen plants at each place, struggling with one another to secure the available supplies of moisture and plant food which, in the majority of cases, are all too small to develop even one plant to perfection.

"In the riverain provinces the pernicious habit exists of not uprooting old cotton plants, but allowing them to remain over for a second season or to become overgrown with bush, thus providing ideal feeding ground for hosts of insect pests, including stainers and boll-worm. Both of

these, but more especially the latter, have done immense damage in the Ilorin Province during the period under review, and urgent measures will have to be adopted to keep them in control. Nothing is at once so practicable and so efficient as clean methods of cultivation, including the uprooting and destruction by fire of the old plants, as well as those of okra and the allied species of *Hibiscus*, as soon as the crop is gathered, thus depriving the insects of their principal host plants."

So far as climate and population are concerned, Northern Nigeria is probably a great deal better equipped for cotton production on a large scale than the majority of British Dependencies. The pack-donkey and pack-ox transport common throughout the Northern Provinces, as well as the innate trading instinct of the Hausas, also offer additional facilities for expansion. But this keen eye to business causes the native, here as elsewhere, to judge cotton entirely on its merits, and where other cultivations prove more profitable, cotton will receive but scant attention. In order to secure a rapid development in the output of cotton from Northern Nigeria every endeavour must be used to make cotton cultivation a more lucrative undertaking. The most obvious way of achieving this end is to establish a variety characterised by early maturity, heavy yield per acre, high ginning percentage, and strong, regular lint at least 1 in. in length. This is the problem which the Agricultural Department has seriously taken in hand.

THE CONVERSION OF LIQUID OILS INTO SOLID FATS

The essential difference between a liquid oil, such as cotton seed oil, and a solid fat, such as palm oil, is that the oils are composed mainly of olein (a compound of glycerine and oleic acid) whilst the solid fats are largely composed of stearin or palmitin (compounds of glycerine with stearic or palmitic acid). Oleic acid is liquid and yields a liquid glyceride (olein), whilst stearic and palmitic acids are solid and yield solid glycerides (stearin and palmitin). It is obvious that if any simple method of converting oleic acid into palmitic acid or stearic

acid could be found, then the commercial manufacture of valuable solid fats from the much less valuable liquid oils should be possible.

This has long been known, and for many years past attempts have been made to devise technical methods for the conversion of liquid oleic acid, and of liquid oils consisting largely of glycerides of oleic and similar unsaturated acids, into solid saturated acids or glycerides, such as stearic acid or stearin, suitable for the manufacture of candles, hard soaps, etc. The technical importance of the problem is at once apparent when it is remembered that large quantities of oleic acid are obtained as a by-product in the manufacture of stearic acid for candles, and "oleins" are similarly obtained as by-products in the removal from oils and fats of "stearins," of high melting point and firm consistence, to be used in the manufacture of margarine, and for other purposes (see this BULLETIN, 1912, **10**, 280).

The liquid oleic acid and "oleins" are of less value than the solid stearic acid and "stearins," and speaking generally most of the liquid vegetable oils of commerce are of much lower value than the solid fats, consequently the possibility of converting liquid oils into solid fats has attracted much attention from chemists and technologists.

Many processes have been proposed for the conversion of oleic acid into solid acid suitable for candle-making, but few appear to have met with industrial success. According to Lewkowitsch (*Chemistry, Technology, and Analysis of Oils, etc.*, vol. ii. (1909), p. 190), the only processes in use in 1909 depended on the treatment of oleic acid with strong sulphuric acid, whereby a partial conversion of oleic acid into hydroxystearic and other solid saturated acids takes place, and the acids are then separated by subsequent distillation. This method has been worked on a large scale. The conversion of liquid unsaturated acids or glycerides into solid saturated compounds is a simple chemical reaction, and consists in reduction with hydrogen, which can in certain cases be carried out readily under laboratory conditions. On a technical scale, however, the process was impracticable until Sabatier and Senderens

introduced their method of reducing organic compounds by hydrogen in presence of a catalyst (*i.e.* a substance which facilitates a chemical reaction between other substances, but is not itself affected by the reaction), such as nickel. Soon after the publication of Sabatier and Senderens's early researches, patents were taken out by Le Prince and Sieveke (German Pat. 141,029, Aug. 14, 1902) and Norman (Eng. Pat. 1,515 of 1903), for the conversion of unsaturated acids, or their glycerides, into saturated compounds by treatment with hydrogen in the presence of a catalyst. Since these dates many patents have been taken out for processes of working, machinery, etc., suitable for carrying out the reduction. It is unnecessary to discuss here these patents or the technology of the process, especially as details can be found, by those interested, in the various technical journals, such as the *Journal of the Society of Chemical Industry* (1912, **31**, 1155). The wide applicability of the process, however, and its great importance to all interested in the oil and oil seed trades, render a brief description of the process necessary. Theoretically one molecule of oleic acid combines, on reduction, with one molecule of hydrogen to form one molecule of stearic acid, according to the chemical equation

$$\underset{\textit{Oleic acid.}}{C_{18}H_{34}O_2} \quad + \quad \underset{\textit{Hydrogen.}}{H_2} \quad = \quad \underset{\textit{Stearic acid.}}{C_{18}H_{36}O_2}$$

Similar reactions take place in the case of other unsaturated glycerides or of other unsaturated acids, such as linoleic and linolenic acids. The conversion of 2,000 lb. of oleic acid would therefore require about 14 lb. or 2,500 cubic ft. of hydrogen gas for its complete conversion into solid stearic acid. The process consists in treating the liquid oil or acid with hydrogen gas in the presence of a catalyst.

Theoretically the quantity of catalyst used is inexhaustible, since, as explained above, it facilitates the reaction but is itself unaffected by it; in practice, however, catalysts lose their activity owing to "poisoning" by impurities. The oil is generally heated, and is brought into ultimate contact with the catalyst either by spraying, by agitating,

or by other means, while the hydrogen gas, which must be carefully purified, is generally applied under pressure. Two essentials of the process are an active catalyst and a cheap supply of pure hydrogen. With regard to the catalyst some form of nickel appears to be used most generally, because of its low cost and high efficiency; palladium, in spite of its great initial cost, has received much attention on account of its high efficiency, and other materials, such as platinum, copper, iron, etc., have also been used to a certain extent. The cheap supply of hydrogen is an important problem; at present the processes most favoured are (1) the iron-sponge steam process, in which steam is decomposed by heated iron, hydrogen and iron oxide being formed, the iron being re-generated for use by reduction with water-gas; and (2) electrolysis of water. Of these processes the former is complicated, and most suitable for large plants requiring over 1,000 cubic ft. of hydrogen per hour, while the latter is particularly suited to smaller plants, and in localities where electric power is obtainable at cheap rates. It possesses the further advantage of producing hydrogen of a high degree of purity, while the capacity of the plant can be increased readily by the addition of further generator units. The iron-sponge steam process is being used at large works in England and on the Continent; the electrolytic process is used in America, and a company has been formed to carry on the hydrogenation of whale oil at Fredrikstad in Norway (*Dipl. and Cons. Repts., Ann. Series*, No. 4,983 [Cd. 6005–156], 1912, p. 11), power for the electrolytic production of hydrogen being obtained from the Hafslund Falls.

Properties of "Hardened Oils"

The hardening of oils by the addition of hydrogen (reduction) in this way can be carried out so that products of varying consistence and appearance are obtained. For instance, if a liquid oil consisting chiefly of olein is completely saturated with hydrogen, the product will consist chiefly of stearin, and will be of hard consistence, while by stopping the process at an earlier stage soft, lard-like fats,

consisting partly of stearin and partly of unreduced olein, can be obtained.

The following figures (Bömer, *Zeit. f. Unters. der Nahrungs u. Genüssmittel*, 1912, **24**, 104) show the change in character produced by reducing a typical liquid oil such as ground nut oil:

	Natural ground nut oil.	Hardened oil. Slightly.	Moderately.	Much.
Saponification value .	191·1	188·3	188·4	189·0
Iodine value . *per cent.*	84·4	56·5	54·1	42·1
Melting point, ° C. . .	—	44·2	46·1	53·5
Solidifying point, ° C. .	—	30·2	32·1	38·8
Character of product .	Yellow, liquid.	White, consistence of lard.		White, consistence of tallow.

The reduction, as shown by the gradual lowering of the iodine value, has not been carried to completion, in which case the iodine value would be *nil*; but even by lowering the iodine value by half, the liquid oil has been changed to a solid of comparatively high melting point. The change in colour from yellow to white which takes place at the same time is of great importance, while the fact that the unsaturated and therefore oxidisable glycerides become saturated, and are thereby rendered non-oxidisable, should tend to render the product less likely to undergo change on keeping. Further, the hydrogenation of the unsaturated acids results, it is stated, in the case of fish oils, in the entire removal of the unpleasant odour and, in great part, of the fishy taste. This is one of the most important features of the new process, as, if borne out by practical experience, it will render cheap fish oils available for purposes such as soap-making, for which they are not naturally well suited owing to the difficulty of deodorising them.

"Hardened oils" produced by this process are already on the market under a variety of names, such as "Talgol," "Candelite," etc. They are obviously suited for a number of purposes, such as soap- and candle-making, as they closely resemble in composition and appearance the natural fats already used. Probably the most important feature of the new process is the possibility of the production of solid edible fats from cheap liquid oils; hardened oils of edible

quality have been manufactured already, and seem destined to play an important rôle in the margarine and allied industries, but it is at present difficult to give a definite opinion on this point. There seems to be no definite ground for objecting to their sale for edible use, though a certain amount of difficulty is experienced in preventing contamination of the fat with nickel, which is unsatisfactory, but it seems highly probable that eventually means will be found of preventing this contamination. According to Bömer (*Chem. Rev. Fett. u. Harz. Ind.*, 1912, **19**, 221) the presence of free fatty acid in the oil is an important factor in avoiding this contamination, while nickel oxide as a catalyst appears to be less desirable than metallic nickel on account of its greater solubility (Ellis, *loc. cit.* p. 1166). The question of the toxicity of traces of nickel is being investigated by the Bureau of Animal Industry of the United States Department of Agriculture.

Conclusions

The hardening of oils by hydrogenation is already being practised on a large scale, and its extensive use in the oil industry in the future is beyond doubt; it must in fact be regarded as the most important advance in the technology of oils during recent years. The probable effect on the oil and allied industries and on the oil and oil seed markets is exceedingly difficult to forecast, as the full possibilities of the process of hardening oils cannot be gauged until the use of the process becomes more general.

A possible effect that at once suggests itself is the lowering of prices of certain of the harder natural fats, *e.g.* palm kernel and coconut oils, which are largely used in the manufacture of edible substances, while the demand for liquid oils which lend themselves readily to the process of hardening may reasonably be expected to increase, with a corresponding increase in value. The present price of coconut oil is abnormally high, as much as £60 per ton being paid for Cochin oil, largely owing to the great demand for the manufacture of edible materials such as margarine; it cannot be doubted that attempts will be made to replace, either wholly or partially, such an expen-

sive material with artificially hardened oils, if these prove suitable for the purpose. If these attempts prove successful they can hardly fail to have some effect on the demand for coconut oil and similar fats. It is somewhat early in the day to speak definitely as to the cost of hardening oils by hydrogenation, but according to Bömer (*Zeit. f. Unters. Nahrungs u. Genüssmittel*, 1912, **24**, 104) it is about £5 per ton. Liquid oils can be purchased at as low a price as £17 per ton for Japanese fish oil. It should therefore be possible to produce from this material a hardened oil which should be at least equal in value to low-grade palm oil, viz. £26 per ton, at a cost of about £22 per ton. The fact that numerous firms of oil manufacturers are interesting themselves in this process is sufficient to show that it is regarded as likely to prove profitable.

GENERAL NOTES

Report on the Work of the Imperial Institute, 1912.—A summary of the work carried out at the Imperial Institute for the Dominions, Colonies, and Dependencies during 1912 has now been issued in the Annual Series of Colonial Reports, No. 778 [Cd. 7050-19].

Mineral Survey of Southern Nigeria.—Since 1904 there has been in operation in Southern Nigeria a Mineral Survey, conducted under the general supervision of the Director of the Imperial Institute.

Reports on the work of the survey are published periodically in the Miscellaneous Series of Colonial Reports, and those for 1911 (No. 85 [Cd. 7067]) and 1912 (No. 86 [Cd. 7110]) have just been issued. They contain summaries of the field work accomplished in Southern Nigeria, and also the principal results of examination at the Imperial Institute of the minerals of economic importance collected by the Surveyors.

During 1911 the Surveyors were principally engaged in examining the Udi-Okana coalfield, and in investigating its extension, especially northwards. A large number of new outcrops were discovered, and this preliminary work showed that the field is large. Numerous samples of the coal were collected, and the analyses made at the Imperial Institute showed that they were quite similar in character to the coals from other parts of the field examined in

previous years. The coal appears, therefore, to be of fairly uniform quality. It is a sub-bituminous coal similar in type to coals which are now largely mined in North America for industrial purposes.

The principal work carried out in 1912 was also in connection with the coal deposits to the north and north-west of Udi, several new occurrences of importance being discovered. Seams varying in thickness from 10 in. to 4 ft. 9 in. were found at various localities in the Okwoga district, proving the northerly extension of the coal deposits well beyond the limit reached during the work of the previous season. Still more important was the discovery of coal of fairly good quality in a seam 1 ft. 8 in. thick in the Iyokolla river, seven miles east of Adani, and fifty-six miles due west of Okwoga station, proving the westerly extension of the coal deposits. This occurrence is of special importance on account of the fact that it is situated only fifteen miles from Ogrugru, on the Anambra river. So far the examination of these coalfields has been limited to surface outcrops, but the fuller investigation by means of boring machinery now in progress may be expected to yield interesting results. The material examined at the Imperial Institute included, in addition to specimens of coal from the various seams referred to above, a clay suitable for the manufacture of fire-bricks; two samples of ironstone, containing 65·65 and 71·78 per cent. of ferric oxide respectively, representing material which would be suitable for the production of steel by the basic process; and two specimens of grey, compact limestone, which would be suitable for agricultural use or for the manufacture of ordinary mortar for building purposes.

South Africa and the Diamond-cutting Industry.—In February 1913 the Parliament of the Union of South Africa appointed a Select Committee to consider the advisability of encouraging the establishment of a diamond-cutting industry within the Union, and the means by which such encouragement may best be effected. The Committee's report was printed and circulated in May 1913, and embodies much evidence of value in connection with the possibility of the establishment of a South African diamond-cutting industry.

The value of the total production of diamonds in the Union up to the present date is estimated at over 170 millions sterling, whilst that for the last twenty years (1893-1912) amounts to over 119 millions sterling. The export of uncut diamonds in 1912 amounted to the local declared value of £10,061,489 from the Union, and approximately £1,800,000 from German South-West Africa. This is a record output, although it does not appear to have exceeded the demand. The value of the diamond pro-

duction of other countries is small and comparatively insignificant.

The revenue derived by the Union from the diamond-mining industry during 1912 was approximately £800,550. The German Government's revenue during the same year was approximately £363,425.

Notwithstanding the increase in production, there has been a substantial increase in the average price obtained for rough diamonds. It is stated that during the last twenty years diamonds have increased in value by 150 per cent., and in the last five years by 67 per cent.

The output of diamonds is controlled so as not to exceed the demands of the market. The diamonds are elaborately sorted in South Africa, and are then sent to Europe.

It is estimated that there are some 23,000 persons engaged in the diamond-cutting industry, chiefly in Amsterdam and Antwerp, at an annual cost of about £5,000,000. Some cutting is also done in China, England, France, Switzerland, Germany, and America. America is at present the largest buyer of South African diamonds, and some of the best stones are said to be perfected in that country.

Attempts have been made at various times to establish diamond cutting as a business in South Africa. The failure of these attempts is attributed to the inability of South African cutters to secure the requisite amount and variety of raw material, owing to the fact that the large companies send all their rough diamonds to Europe. It is possible to obtain rough stones locally from river diggers, but these do not furnish the variety of material required for the establishment of a successful trade in diamond cutting.

The Committee concludes that it is desirable to establish a diamond-cutting industry in South Africa; that local conditions are favourable for the development of the trade; and that there will be no difficulty in securing foreign skilled labour to carry on the work. To aid in the establishment of this industry, the Committee suggests (1) that the Government, through the medium of its large interest in certain mines, should use its influence to secure such a supply of rough diamonds as may be necessary for local cutters who wish to start in the trade; (2) that a protective tax of 10 per cent. should be imposed as an export duty on the value of all uncut diamonds sent out of the Union.

Mineral Production of the Union of South Africa.—According to the *Annual Report of the Mines Department of the Union of South Africa for* 1912, the total value of the mineral output of the Union for that year amounted to £52,711,761, an increase of £5,032,467 as compared with 1911.

Of this total, gold contributed £38,691,688, which is an

increase of £3,642,647 on the value for the previous year. This is 39 per cent. of the world's total production of gold, which for 1912 was estimated to be £98,000,000. The amounts of gold produced by the different provinces were as follows:

	Quantity. *Fine oz.*	Value. £
Transvaal	9,107,511·562	38,686,250
Cape Province	38·188	162
Natal	1,242·061	5,276

The total value of the diamond output for the year was £10,061,489, an increase of £1,314,765 on that for 1911. This output was distributed as follows:

	Quantity. *Carats.*	Value. £
Transvaal	2,131,406·03	2,386,979
Cape Province	2,325,548·88	6,190,966
Orange Free State	614,927·43	1,483,544

Of the total 5,071,882·34 carats produced, 4,887,053·45 were "mine stones," the values of which per carat were 19*s.* 6*d.* for Transvaal, 50*s.* 3*d.* for Cape, and 48*s.* 2*d.* for Orange Free State stones, the average value being 37*s.* 1*d.* per carat. The remaining 184,828·89 carats were obtained from alluvial workings, and their values per carat were 92*s.* 7*d.* for Transvaal, 120*s.* 6*d.* for Cape, and 105*s.* 11*d.* for Orange Free State stones, the average value being 107*s.* 9*d.* per carat.

The output of coal was valued at £1,999,378, an increase of £64,225; that of copper at £556,978, an increase of £4,833; that of tin at £367,699, a decrease of £44,172; and that of silver at £124,374, an increase of £25,867 compared with 1911.

Among the less important minerals there were increases in the output of magnesite, lead ore, mica, corundum, salt, crocidolite and steatite; and decreases in asbestos, graphite, zinc ore, manganese ore, kaolin, limestone, flint, kieselguhr, and verdite.

Mineral Production of British Columbia.—According to the *Annual Report of the Minister of Mines for British Columbia*, the year 1912 was a very successful one from a mining standpoint, and the mineral production was the greatest in the history of the Province. The gross value of the output for the year was $32,440,800, an increase of $8,941,728, or about 38 per cent. on that for 1911.

All the important economic minerals of British Columbia, viz. coal and ores of copper, gold, silver, lead, and zinc, shared in this increased output.

The total output of coal was 3,025,709 tons (of 2,240 lb.),

valued at $9,200,814, an increase of 727,991 tons, or 31·5 per cent., on that for 1911; but 113,526 tons less than that for 1910, during which year there was a record output. Of the coal produced 1,882,827 tons was consumed in Canada, 858,981 tons exported to the United States, and 108,157 tons to other countries, whilst 175,744 tons was lost in washing and screening. Of the total Canadian consumption of coal, 396,905 tons was used in the manufacture of 267,564 tons of coke, of which 50,257 tons was exported to the United States.

The most notable feature of the mineral production during 1912 was the remarkable increase in the production of copper, the output of which had an estimated value of $8,408,513. This is a record figure, being 84 per cent. in excess of that for 1911, and a substantial increase on 1908, which was the previous best year. The average assays of the copper ores of the chief fields, based on copper recovered, were as follows: Boundary, 0·87 per cent.; Coast, 3·625 per cent.; Rossland, 0·521 per cent.

The value of the gold output was estimated at $5,877,942, of which $5,322,442 represents lode mining and $555,500 placer mining, corresponding to increases of $596,929 and $129,500 respectively as compared with 1911. Practically all the placer gold was obtained from the Atlin and Cariboo districts. About 75 per cent. of the lode gold production of the Province is obtained from the smelting of copper-bearing ores, the remainder from stamp-milling. The contributions of the three chief camps to the total gold output were: Rossland, $2,729,949; Boundary, $2,167,229; and Nelson, $361,994.

Other significant features of the output were silver, $1,810,045; lead, $1,805,627; and zinc, $316,139; these show increases of $851,752, $736,106, and $187,047 respectively on the outputs for 1911.

Platinum occurs in many of the alluvial gold-workings, but its recovery as a by-product is attended with considerable trouble, and there is consequently no appreciable production of this metal. The discovery of platinum in dyke rocks near Nelson had been reported during the year, but a careful investigation of the supposed occurrence by the Bureau of Mines had negative results.

Iron ore does not figure in the production, although it is stated that there are numerous deposits of considerable size containing ore of good quality.

The Grading of South African Maize, Kaffir Corn, and Jiba.—For several years past regulations for the grading of maize, kaffir corn, and jiba intended for export from South Africa have been issued by the Minister of Agriculture. The approved grades for the 1913 season are given in the following table:

Maize Grades

Grade Mark to be shown on bags.	Class.	Description.
1.	F.W. 1	To be sound, dry, plump, and well cleaned, with a maximum of 3 per cent. of yellow, discoloured, or defective grain.
2.	F.W. 2	To be sound, dry, and reasonably cleaned, and not containing more than 8 per cent. of defective grain and 5 per cent. of other coloured grain.
3.	F.W. 3	To be sound, dry, and reasonably cleaned, and not containing more than 13 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size and shape.
4.	F.Y.	To be sound, dry, and reasonably cleaned, and not containing more than 9 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size.
5.	R.W.	To be sound, dry, and reasonably cleaned, and not containing more than 9 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size.
6.	R.Y.	To be sound, dry, and reasonably cleaned, and not containing more than 9 per cent. of defective grain and 5 per cent. of other coloured grain. Berries may be of irregular size.
7.	F.M.	To be sound, dry, and reasonably cleaned, and not containing more than 10 per cent. of defective grain.
8.	R.M.	To be sound, dry, and reasonably cleaned, and not containing more than 10 per cent. of defective grain.
9.	No grade	To include all maize which cannot be classed in a higher grade, but in dry condition and fit for shipment.

Kaffir Corn Grades

K 1	White	To be sound, reasonably clean, and not to contain more than 5 per cent. of coloured grain.
K 2	Pink	To be sound, reasonably clean, and not to contain more than 10 per cent. of white grain.
K 3	Mixed	To include any other sweet kaffir corn (excluding jiba or jhiba) which cannot be classed under pink or white, provided it is sound and reasonably clean.
K 4	No grade	To include all kaffir corn in dry condition fit for export (including smutty) which cannot be classed in a higher grade.

Jiba Grade

J	Jiba or Jhiba	To include the variety known as jiba, in sound condition and reasonably clean.

In this table F.W. = Flat white, F.Y. = Flat yellow, R.W. = Round white, R.Y. = Round yellow, F.M. = Flat mixed, R.M. = Round mixed.

Samples of the various grades of these products have been placed on exhibition in the Union of South Africa Court, in the Public Galleries of the Imperial Institute.

Cotton Growing in the Ivory Coast.—The cultivation of cotton in the Ivory Coast is receiving careful attention at the hands of the French Colonial Cotton Association, and an account of recent work has been given in *Bulletin de l'Association Cotonnière Coloniale*, No. 57, 1913. A preliminary selection of the numerous varieties of cotton met with in North Bwake has been made by separating the smooth seeds from those bearing fuzz or down with a view to distributing the former to the natives. The smooth-seeded cottons are of two varieties, known as "Guiesse bla" (or female cotton) and "Guiesse yassoua" (or male cotton). The seeds of "Guiesse bla" are free from one another, whereas those of "Guiesse yassoua" are united in groups or kidney-shaped masses of from two to eight seeds.

A study of these two varieties has indicated that "Guiesse bla" is the more suitable for cultivation, for the following reasons: (1) The "yassoua" kind does not behave well on ginning, as the seeds remain attached to one another and impede the action of the saws. (2) The "yassoua" seeds must be detached from one another before being sown, for if a complete group is planted, the roots of the seedlings become entangled and thus render it very difficult to thin out the plants without pulling up the whole cluster; this separation of the seeds by hand adds considerably to the cost of cultivation, since it takes twenty men two days to prepare the necessary quantity (20 kilos.) to plant a hectare. (3) "Guiesse bla" is already more commonly grown by the natives than "Guiesse yassoua," and its fibre is regarded by commercial experts as somewhat more valuable than that of the latter.

Efforts will therefore be made to improve and extend the cultivation of "Guiesse bla" and to establish a uniform type by avoiding the distribution of "Guiesse yassoua" among the natives. Hitherto, there does not seem to have been any difference observed in the plants of these two varieties except in respect of the seed, and it is considered possible that the two forms of the seed may both be derived from one and the same cotton plant, and that the union of the seeds may perhaps be merely an accidental character of certain bolls. Experiments are being made to elucidate this question.

The natives, with the encouragement of the Administration, have planted somewhat largely this season, and the fields have been well tended. Sometimes the plants are cut down at the end of the first season and allowed to grow up again, although it is recognised that cotton of the second year's growth is of comparatively poor quality. Cotton is usually grown in admixture with food-plants, such as maize, cassava and yams, but in the Norhogo region, to the north of Bwake, the natives grow it as a separate crop in well cultivated fields. When, two or three years hence, the rail-

way reaches this district, good cotton harvests may be anticipated.

Cotton Protection Rules in Uganda.—The subject of cotton protection has been dealt with previously in this BULLETIN (1913, **11**, 514) where the regulations made for Nyasaland are described. In Uganda the "Cotton Ordinance Rules, 1909," and "Cotton Ordinance Rules (No. 2), 1909," are being repealed, and "The Uganda Cotton Rules, 1913," of which the following is a summary, have been sanctioned. All cotton must be grown from seed obtained from the Government, and no cotton plants are to be left to produce a second season's crop; all must be uprooted and destroyed within one year from the date of sowing, and the Director of Agriculture may fix a date before which all the previous season's plants must be uprooted and destroyed. Every hand cotton gin in use must be registered annually during October at the Department of Agriculture; and all seed obtained from such gins must be at once destroyed, unless it is being supplied to the Government, or exported, or its germinating power is destroyed. Raw cotton may only be bought by persons licensed by the Director of Agriculture, or by agents having permits from such licensed persons; such permits must be approved by the District Commissioner. No fee is payable in respect of any licence issued under these rules, but the holder of a licence must pay a fee of one rupee in respect of every permit issued by him. The Governor may fix places in any part of the Protectorate for the purchase and sale of raw cotton, and none must be bought or sold elsewhere in such parts. Certain areas may be fixed by the Governor in which the purchase and sale of raw cotton shall be unlawful except under prescribed conditions. All raw cotton and every ginning factory may be inspected at any reasonable time by an officer of the Department of Agriculture.

Certificates of Freedom from Plant Pests.—In view of the legislation enacted by various countries to prevent the introduction of insect and fungoid pests that attack plants (cf. this BULLETIN, 1913, **11**, 334), the Board of Agriculture of the United Kingdom is prepared to issue to nurserymen the certificates required by various importing countries, and they have published in the *Journal of the Board of Agriculture* (1913, **20**, 640) the conditions under which such certificates will be issued. Application should be made to the Board a few days before the consignment is to be despatched. If the plants are to be sent by parcel post they should be sent to the Secretary of the Board in London ready packed in a box, but with the lid not nailed down, and accompanied by the necessary stamps, labels, and Customs declaration. They will then be examined, and if declared healthy or free from certain specified pests, the

box will be despatched by the Board. No charge is made for examining a consignment in one box if the gross weight is less than 11 lb. For larger consignments, whether packed in two or more boxes, the charge for packages not exceeding 56 lb. in weight is 2*s*. 6*d*., and for packages between 56 lb. and 1 cwt. 5*s*. Packages above 1 cwt. in weight cannot be examined at the Board's offices, and in such cases special arrangements must be made.

Under the Plant Quarantine Act of 1912 of the United States, nursery stock shipped between October 1 and May 31 must be inspected on or after October 1, and if shipped during the growing season must be examined at the time of packing. Growers who intend to export to the United States should inform the Board as early in the year as possible. Preliminary inspections of the nurseries will be made from time to time during the summer months, and a final examination as early as possible in October. The fee charged will in most cases be £2 2*s*. a year for each nursery, for which sum an unlimited number of certificates and copies can be obtained as required up to May 31 in the following year, provided that the nursery is found to be free from injurious plant disease and insect pests. Any stock shipped between May 31 and October 1 will be examined under the conditions described in the first paragraph.

Nursery stock is not admitted into the United States unless a permit for the entry has been obtained from the Department of Agriculture at Washington by the importer, and the invoice is accompanied by a declaration by the shipper giving particulars as to the place where the stock was grown, date of inspection, permit number, etc. This declaration must be signed by an American Consul. The packages also must be marked with full particulars.

Certificates relating to phylloxera, and to the absence of certain diseases in the neighbourhood in which plants to be exported were grown, can also be obtained from the Board.

The Agricultural Department of the Belgian Congo.—A short account of the work of this department is given in the *Bull. Soc. Belge d'Études Coloniales* (1913, **20**, 500), taken from a letter of M. Aug. Chevalier, which calls attention to the great efforts that are being made to promote the agriculture of the country. Out of an annual budget of £1,800,000, for three years nearly £160,000 per annum has been given to agriculture. The department employs 160 European officials and 10,000 native labourers, and in addition thirty officials are attached to the directorate in Brussels. The department keeps itself well informed of what is being done elsewhere in similar climates, and five or six specialists have been sent to India, Malaya, and the United States, with a view to

utilising their observations in the Congo. At the Botanic Garden of Eala, near Coquilhatville, there is a staff of eight Europeans, including a chemist and an entomologist, and 550 natives are employed; the budget of the garden is about £6,000. The area is 250 hectares (618 acres), of which 75 hectares (185 acres) form the botanic garden proper. Here are grown specimens of the useful cultivated plants of all hot countries, and efforts are being made to include all known varieties of the plants producing rubber, coffee, cocoa, cinchona, tea, and bananas, so as to have materials for making experiments to discover those best suited to the country. In the remaining 175 hectares (432 acres) such experiments are carried out; trials are made to see how different varieties of a plant behave under different methods of cultivation, in different kinds of ground, and with and without manure. Great attention is given to all the varieties of coffee trees, the experimental plots being sometimes as much as a hectare (2·47 acres) for each variety. Many practical results have been attained: thus it has been found that in the equatorial zone Hevea grows nearly as well as in Malaya, and gives as much rubber. Already 1,000 hectares (2,470 acres) of it have been planted, and it is proposed to plant in the future 1,000 hectares per annum. Several companies are following this lead, and are beginning to plant Hevea, and plantations of rubber-vines and of Funtumias are being given up. The varieties of coffee tree which are most resistant to diseases and most productive have been determined so that planters can now proceed with certainty. It has been found that tea grows very well in the Congo, but the product is deficient in aroma, and efforts are being made to overcome this defect.

The Agriculture of Abyssinia.—An account of the climate and agriculture of Abyssinia is given by Alfred Kostlan in the *Tropenpflanzer* (*Beihefte* 1913, **14**, 183). The country is remarkable for the great variations in altitude of its different parts, and consequently, although lying within the tropics, it possesses many different climates and exhibits all phenomena of the East African flora, from that of the desert to that of high elevations. It includes most of the desert of Afar near the Red Sea, and two elevated plateaus, namely, that of Abyssinia and that of Somaliland, which stand like islands separated by the great East African trough or depression. The mountains reach 15,000 ft. in height, and in some places it is possible to pass in a few hours from a region of palms to icy plateaus where nothing will grow. The Abyssinians recognise these variations in height and climate and designate localities as "Kolla," or low lands and deep valleys; "Woina-Deka," or land of medium altitude; and "Deka," the upper

highlands. Many different classifications of the various climatic zones have been made, but the author thinks that from an agricultural point of view the following is sufficient and appropriate: (I.) Kolla, land up to 1,700 metres (5,600 ft.), divided into Lower Kolla, up to about 1,000 metres (3,280 ft.), and Upper Kolla, ranging from about 1,000 to about 1,700 metres; (II.) Woina-Deka up to about 2,500 or 2,600 metres (8,200 or 8,530 ft.), divided into Lower Woina-Deka, up to about 2,000 metres (6,560 ft.), and Upper Woina-Deka, up to about 2,500 or 2,600 metres; (III.) Deka, land of about 2,600 metres and over, divided into Lower Deka up to about 3,700 metres (12,140 ft.), and Upper Deka, land of about 3,700 metres and over. The Lower Kolla is essentially the zone of tropical, and the Upper Kolla that of sub-tropical vegetation, whilst cereals flourish in the Woina-Deka and the Lower Deka.

Like other places in the tropics, Abyssinia has a rainy season occurring with regularity, though the time of its occurrence is different in different localities. In the coast district of the Red Sea and in the eastern declivity of the high land the rainy season comes in winter, whilst in the whole high land it comes in summer; a narrow strip lying between these has a share of both the winter and of the summer rainy seasons. Adis-Ababa, the capital, situated at an altitude of 8,000 ft., has the highest rainfall of the stations where the fall is recorded. Here the annual fall amounts to 50 in.; October to February are dry, and about one half of the total comes in July and August; the mean annual temperature is 60° F.

The following crops and plants are grown in the zones:

In the Lower Kolla: maize, dura (*Sorghum vulgare*), sesamum (*Sesamum indicum*), Niger seed (*Guizotia abyssinica*), sugar cane, bananas, papaws, coffee, tschat (Abyssinian name for *Catha edulis*), cotton, Sansevieria.

In the Upper Kolla: the same, omitting Sansevieria and adding wheat; barley; ragi (*Eleusine coracana*); teff (Abyssinian name for *Eragrostis abyssinica*), used for making a kind of bread; lablab beans (*Dolichos Lablab*); chillies (*Capsicum abyssinicum*); ginger; *Amomum corarima*; gescho (Abyssinian name for *Rhamnus prinoides*), a shrub the leaves of which, like hops in Europe, are used in making beer; castor oil plant; tobacco; many fruits and vegetables.

In the Lower Woina-Deka: the same as in the last zone, but omitting tschat, ginger, and *Amomum corarima*, and adding oats, rye, peas, beans, lentils, gram or chick pea (*Cicer arietinum*), mustard, coriander, *Nigella sativa*, safflower (*Carthamus tinctorius*), flax.

In the Upper Woina-Deka: wheat, barley, oats, rye, maize, dura, teff, ragi, peas, beans, lentils, gram, Niger seed, mustard, chillies, coriander, *Nigella sativa*, safflower,

gescho, castor oil plant, tobacco, flax, and fruits and vegetables.

In the Lower Deka: wheat, barley, oats, rye, teff, peas, beans, lentils, gram, flax, and many fruits and vegetables.

Musa Ensete is grown in the Woina-Deka as a fibre plant, and a kind of bread is prepared from the inside portion of the stem. The fibre is used to make cords, clothes, and artistic bags. Two kinds of coffee are grown, namely Harrar coffee and the so-called Abyssinian coffee. The first was introduced into Harrar from Arabia: the bean is large and of a fine green colour, but somewhat bitter; the quantity produced is not large. The Abyssinian coffee has a smaller bean, also of a fine green colour, with a stronger aroma; it is mostly obtained from wild coffee trees growing in the southern provinces, some is also produced in numerous plantations.

The Abyssinian methods of cultivation are generally primitive and superficial, but in the case of certain plants, for instance, coffee, gescho, *M. Ensete*, and chillies, they are more careful.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

AGRICULTURE

Soils.—In the analysis of soils by the usual process of acid digestion of the material passing a 1 mm. sieve, the quantity of phosphoric acid found is sometimes considerably less than that found by the fusion method.

An account of an investigation of this point carried out by the Soils Bureau, U.S. Dept. Agric., is given in *Journ. Indust. and Eng. Chem.* (1913, **5**, 566). It was found that acid extraction removed from 4 to 100 per cent. of the total phosphoric acid present in a number of soils examined, and mineralogical analyses of the soils giving low results showed that they contained apatite enclosed in quartz grains, and therefore protected from attack by acid. It is suggested that a minor factor contributing to this deficiency is the presence in minute quantity of phosphates insoluble in hydrochloric acid.

The partial sterilisation of soils by means of lime is discussed in a paper by H. B. Hutchinson in *Journ. Agric. Sci.* (1913, **5**, 320). The investigation, which was carried out at the Rothamsted Experimental Station, was undertaken in order to account for certain results obtained

when lime is applied to soils, which are not explained by the increase in plant food caused by liming. It has been found that, as an antiseptic, lime has an effect intermediate between that of volatile solvents, such as toluene, and that due to sterilisation by burning (see this BULLETIN, 1911, **9**, 290). Laboratory experiments showed that the effect of the lime when added to the extent of 0·25 to 1·0 per cent. was to destroy many bacteria, to cause a large diminution in bacterial activity, and to kill the larger protozoa. The diminution in bacterial activity continued until all the lime was converted into calcium carbonate, when bacterial activity and the supply of available plant food both increased. The results of pot culture experiments largely confirmed those obtained in the laboratory.

Manures.—Amongst the substances recently suggested and used for manurial purposes is the loggerhead sponge. According to a recent communication from the Soils Bureau, U.S. Dept. Agric., published in the *Journ. Indust. and Eng. Chem.* (1913, **5**, 850), these sponges contain, when air-dried, almost 4 per cent. of nitrogen, and from 0·75 to 1·0 per cent. each of phosphoric acid and potash. The organic matter amounts to about 40 per cent., and the lime and magnesia (chiefly lime) to about 5 per cent. These sponges grow in profusion in the shallow waters of the Florida Keys, and are used locally as a manure. They are said to be suitable for manuring citrus trees.

FOODSTUFFS

Maize.—In most varieties of maize the anthers open previously to or simultaneously with the appearance of the silks (stigmas) on the same plant, and pollen is still falling when the silks are in a receptive condition. For this reason self-pollination, which is said to reduce the vigour of the maize plant, is more likely to occur than cross-pollination. On the other hand, if the stigmas should ripen first, the proportion of cross-pollinated seed would be greatly increased, to the advantage of the plants, while self-pollination could still take place in the event of cross-pollination failing. This question is dealt with in *Circ.* No. 107, 1913, *Bur. Plant Ind. U.S. Dept. Agric.*, which records the discovery of a proterogynous maize in Granada, Spain. This variety is a red maize, having very small ears, and of practically no economic importance. The discovery is recorded, however, in the belief that those interested in developing new types of maize will find valuable breeding material in this strain.

Sugar.—The *Agric. Journ., Union of South Africa* (1913, **5**, 931) records a new sugar cane pest in Natal. The attack was investigated by the Assistant Chief of the Division of Entomology, who reported that the trouble was caused by

a moth caterpillar, which webs together the immature leaves forming the spike of the cane. The pest occurred on "Uba" cane, 99 per cent. of the spikes being infested, while adjacent plants of the "Black Seedling" and "Green Cane" varieties were immune. The damage was not serious, as the depreciation brought about by the destruction of a certain amount of leaf tissue, and the delayed activity of the enfolded leaves, are of minor importance. On this account the control of the insect at present does not call for serious consideration.

Oils and Oil Seeds

Castor Seed.—The castor oil plant is generally stated to be almost immune from fungoid pests, but the crop has been found to be attacked in India by a species of *Cercospora*, and also by a species of *Phytophthora*. The damage caused by *Cercospora* is confined to the leaves, and is not fatal to the plant. It is, however, a serious menace to the eri-silk industry, as the leaves of the castor plant form the food of the eri-silk caterpillars.

The species of *Phytophthora* has been fully investigated by Dastur (*Mem. Dept. Agric. India, Bot. Ser.*, 1913, **5**, 177). It appears to be the most serious fungoid pest of this crop in India, as it destroys seedlings and also attacks older plants. It is most prevalent in abnormally damp seasons, and in low-lying or badly drained localities, where 30 or 40 per cent. of the seedlings may be killed. The first indication of the disease is the appearance of a roundish patch of unhealthy, dull green colour on both surfaces of the cotyledons, which next hang down from the point of attachment. The disease then spreads to the petiole, and thence to the growing point of the plant. In older plants the disease is localised on the leaves, where it causes brown patches, the leaves having a tendency to fall prematurely. In the field the disease does not appear to attack the tougher parts of the castor plants, such as the petioles of large leaves and stems with thick epidermis, or the fruit and flowers, although these portions are readily attacked when inoculated in laboratory experiments; this difference is said to be due to the different climatic conditions to which the field crop is exposed. The author has investigated fully the morphology of this pest, and concludes that it is a new species, for which the name *Phytophthora parasitica* is proposed.

Coconuts.—Attention is drawn in the *Times* of July 1, 1913, to the possibility of establishing further coconut plantations in Zanzibar. The tree does well in the island, and good copra is produced, although no mechanical drying plant is yet used. The copra exported during 1912 was valued at £190,937.

The larvæ and adult insects of the coconut leaf-miner beetle (*Promocotheca cumingii*, Baly) have been found to attack young coconut trees in the Philippine Islands (*Philippine Agric. Rev.* 1913, **6**, 228). So far old palms have not been attacked. It is recommended that infested leaflets should be removed and adult beetles, etc., destroyed.

An article entitled "Copra and Margarine," in the *Times* of October 20, 1913, calls attention to the increasing importance of copra caused by the large demand for coconut oil in the manufacture of edible fats and in other industries. The information given is quite useful, but a number of statements are made which require to be supplemented; for instance, it is stated that "the present-day high value of copra is due to the oil it contains; the commercial importance of copra begins and ends with the presence of this oil." The oil is certainly the most valuable product, but no mention whatever is made of the residual oil cake, of which enormous quantities are produced, and which sells for about £8 per ton.

The native method of preparing coconut oil by crushing and boiling the "meat" is alluded to as having been employed "in early times"; it would be more correct to say "since early times," as the process is still largely used, and some of the highest-grade oil on the market, viz. "Cochin" oil, is produced by this means.

It is also stated that "the majority ship their produce in the form of copra" and "the oil may be said to concern, comparatively, a very limited number of refiners and manufacturers"; this is misleading in view of the very considerable quantities of oil exported from India and Ceylon, and produced there by machinery or by native methods.

It is also stated that coconut oil is now used as salad oil; it is of course possible that coconut olein (see p. 661) could be used for this purpose, but it is most unlikely that any appreciable quantity has been put on the market as salad oil.

The statement that the "cream" of chocolates is "often made of coconut oil" does not correspond with recently published information on this point. Thus Bolton and Revis (*Fatty Foods*, p. 72) state that the "cream" of chocolates does not contain fatty matter, but is composed of sugars and starch. What is probably meant is that the natural cocoa-butter of cocoa nibs is often expressed and sold as such, the residual cocoa being then mixed with a cocoa-butter substitute made from coconut oil for conversion into the chocolate paste used for covering chocolate creams. Quantities of coconut oil are used in making the "icing" layer of ice-wafer biscuits and in the manufacture of sweets and other confectionery, but no mention is made in the *Times* article of these uses. From the prominence given to the "new tasteless and long-keeping form" of

coconut oil it might be imagined that the preparation of edible coconut oil was a very recent innovation, whereas large quantities have been produced for years past; in fact, Lewkowitsch mentioned the increase in the manufacture of edible coconut oil in 1909 (*Chemistry, Technology, and Analysis of Oils, Fats, and Waxes*, ii. 518), and stated that the quantity produced "a few years ago in Europe alone" was "about 10,000 tons per annum and rose rapidly to 50,000 tons."

The reference to "doubtful animal fats" used in margarine manufacture is somewhat belated, since, although the use of coconut oil in margarine has undoubtedly increased enormously during recent years, very large quantities of animal fats and oils are still used, and the conditions of manufacture are now beyond suspicion, whatever may have been the case in the past.

The statement that Continental firms are making from milk and coconut oil a "butter as wholesome, real, and palatable as the best dairy butter" is far too daring; such a material may be as wholesome and palatable as butter, but one need only consult any reliable work on food analysis to see that no court in the United Kingdom would allow the sale of such a substance as "real butter."

Ground Nuts.—The cultivation of ground nuts in Gujerat was formerly considered unprofitable, but experiments made recently show that this view is hardly correct. The crop is now recommended by the Agricultural Department (*Agric. Journ. India*, 1913, **8**, 178), and its cultivation in this district is increasing gradually.

The chief drawbacks to its cultivation appear to be (1) liability to damage by crows, theft, etc. This difficulty should be gradually overcome as the crop becomes more general; moreover, such a valuable crop should pay for careful watching. (2) The high cost of cultivation. It was found that the cost of cultivation of the late varieties tested was about Rs. 113 per acre, the profit being about Rs. 12 with Senegal nuts and about Rs. 62 per acre with Tamboo nuts. The early varieties only cost about Rs. 80 per acre, the profits being Rs. 71 with small Japanese nuts and about Rs. 52 per acre with Spanish nuts. (3) Scarcity of labour for harvesting. This can be obviated to a great extent by growing early varieties, which mature when there is less demand for labour, and which are easier and cheaper to harvest. The early varieties cost about Rs. 31 per acre to harvest; the late varieties have to be hand-dug owing to the hardness of the soil, and cost about Rs. 63 per acre, but this difficulty can be overcome by judicious irrigation where this is possible. It is concluded that ground nuts can be made as profitable in Gujerat as tobacco, which is the principal money-making crop. The

ground nut possesses the advantage of being fairly resistant both to drought and wet, and is also comparatively free from attacks of white ants or hairy caterpillars (*Katras*) which cause much damage to other crops. Ground nuts are also valuable in the rotation of crops; a three years' rotation of cotton, ground nuts, and bajri (*Pennisetum typhoideum*) being recommended.

Experiments in Sierra Leone with Gambia ground nuts (*Ann. Rept. Agric. Dept. Sierra Leone*, 1912, p. 9) have shown that better crops are obtained if the nut shells are removed before sowing; the Konnoh tribesmen split one end of the shell with a view to assisting germination. The yields obtained in the experiments were not very good, probably owing to late sowing and to the attacks of rats, hogs, and termites. Further experiments are to be made with a view to ascertaining whether deep hoeing leads to an increased crop, as is the case in other countries.

Oil Palm.—The comparatively small quantity of palm kernels exported from the Eastern Province of Southern Nigeria is further discussed by Unwin (*Nigerian Customs and Trade Journ.* 1913, **3**, 319; cf. this BULLETIN, 1913, **11**, 525). It is suggested that the introduction of nut-cracking machinery will tend to a greater production of kernels, as many kernels are wasted at the present time. The machines are somewhat expensive for purchase by natives, but could be supplied to chiefs and other responsible people on a hire-purchase system. Nut-cracking machines have been installed at some places, *e.g.* Degema, and a large increase in production at these places has resulted; in fact the natives are bringing in more nuts than can be dealt with, while hand cracking is being abandoned in some districts. It is suggested that skilled men might be placed in the markets to crack nuts by machinery, and also that natives should be encouraged to cultivate the palms in plantations and not to rely on the scattered wild trees. The primitive devices used for cracking nuts by hand might also be improved on by the use of an iron block and a handleless striker or "maul" (*Nigerian Customs and Trade Journ.* 1913, **3**, 291, 324).

Para Rubber Seed.—In a note published in the *Tropical Agriculturist* (1913, **40**, 311) Wicherley calls attention to the fact that Para rubber seed has been sold in Ceylon at prices which yield a profit of about £1 per ton to the planters. A large firm of oil manufacturers in England valued the kernels at about £9 10s. per ton, and stated that there would be no difficulty in disposing of 1,000 tons. Some difficulty seems to be experienced in separating the kernels from the shells, while the kernels are said to be liable to attack by insects unless thoroughly dried.

Several thousands of tons are reported to have been

offered for sale in the Malay States, but the prices asked were prohibitive for export purposes.

Soy Beans.—It has not been found possible to cultivate soy beans with success in Montserrat (*Rept. Botanic Station, Montserrat*, 1911–12, p. 2). Five generations have been grown on the same plot, but the plants have never exceeded 8 in. in height, and have generally borne only about a dozen pods each. Soil from Trinidad in which soy beans had been grown successfully was sown with the beans in one case, in the hope of inoculating the soil with the nitrogen-fixing bacteria; but this had no beneficial result.

Miscellaneous.—The oil from the seeds of the Ceara rubber tree has been examined by Rideal and Acland (*Analyst*, 1913, **38**, 259), with similar results to those already recorded in this BULLETIN (1906, **4**, 364). The authors appear to consider that the seeds are likely to be of commercial value as a source of oil. The seeds, however, only contain 15 to 16 per cent. of oil, and consist of about equal proportions of kernel and hard woody shell which cannot be removed easily from the kernel. The only feasible method of obtaining the oil from such seeds would be to grind the whole seeds and to extract the oil by solvents. Such processes are of course largely used in Europe, but are not yet employed in the tropics, while it would obviously be unremunerative to attempt to ship seeds with so low an oil content and so large an amount of hard woody shell to European oil mills.

The same authors (*loc. cit.* p. 259) also examined the seeds of *Funtumia elastica*; these were found to contain 31 to 33 per cent. of oil which resembles that from Ceara and Para rubber seed. The seeds are stated to contain cyanogenetic glucosides.

The seeds of the soft-shelled pinon or grey pine (*Pinus monophylla*, Torr. & Frem.), which grows on the slopes of the Sierra Nevada Mountains, are gathered for food in large quantities by the Indians. Adams and Holmes have examined these seeds (*Journ. Indust. Eng. Chem.* 1913, **5**, 285), and state that the air-dry kernels contain from 16 to 22 per cent. of oil, which was found to consist chiefly of olein, with smaller amounts of glycerides of stearic, palmitic, lauric, and linoleic acids. No information is given as to the possibility of using the seed as a commercial source of oil.

RUBBER

Hevea brasiliensis.—In *Bulletin Dept. Agric. Ceylon* (1913, No. 4, p. 61), the Director of Agriculture gives the results of tapping old trees at Heneratgoda systematically for 3½ months. One tree already noted for its high yield (see this BULLETIN, 1911, **9**, 427; 1912, **10**, 495) gave a total yield of

45 lb. 3½ oz. of dry rubber. The next most productive tree yielded 24 lb. 9¼ oz. of dry rubber. The general result of the experiments is that the most productive trees are those which have the most room to extend. The author points out that *Hevea brasiliensis* must have room to extend in at least one direction (in one case the root was found at a distance of 80 ft. from the trunk), and recommends planting the trees in fours, each four at some distance from the neighbouring fours, so that every tree may extend fully on two sides.

Tapping experiments are also described by Dr. A. W. K. de Jong in the *Mededeelingen No. IV. van het Agricultuur Chemisch Laboratorium, Departement van Landbouw, Nijverheid en Handel, Buitenzorg*, 1913. The experiments were designed to test the effect of direction and angle of slope of the tapping cuts. Numerous tables are given showing the results of individual tappings. It was found that cuts of equal length, at the same height from the ground, and sloping in the same direction, yield practically the same weight of rubber, whether the cuts are 5 cm. apart or on opposite sides of the tree. A long cut yields less rubber than two shorter cuts which are together as long as the long cut, and slope in the same direction. In the case of cuts of equal length, at the same height from the ground, and sloping at the same angle but in different directions, it was found that those sloping up to the left gave an average of 15 per cent. more rubber than those sloping up to the right when they were on the same side of the tree. Also, when the cuts were on opposite sides of the tree those sloping up to the left yielded 10 per cent. more rubber than those sloping to the right. The author explains these results as due to the fact that the laticiferous vessels of *Hevea brasiliensis* incline somewhat to the right as stated by Petch (*Physiology and Diseases of Hevea brasiliensis*, pp. 111, 112). The cuts sloping up to the left will therefore cut more vessels than those sloping up to the right, and tap more latex.

Numerous tables are given showing the relation of the yield of rubber to the angle of inclination of the cuts; the cut which runs perpendicular to the direction of the laticiferous vessels will tap the maximum number and yield the greatest amount of latex. The author concludes that the herring-bone system, the V system, and the cuts sloping up to the right, are less rational than the cuts inclined to the left.

The same journal (p. 35) describes an experiment on the effect of manures on the growth of *Hevea brasiliensis*. Two hundred and fifty-two trees were experimented with in eight series. Superphosphate of lime, chloride of potash, and sulphate of ammonia, either alone or mixed, were applied on April 12, 1911, and again at intervals of from

two to four months up to August 2, 1912. The girth of the trees was measured on November 20, 1911, April 8, 1912, and November 17, 1912. The average increase of girth per tree of the manured over the unmanured trees for 1½ years was 1·25 cm. in the case of the mixture of all three manures, 1·2 cm. for a mixture of chloride of potash and sulphate of ammonia, and 1·1 cm. for sulphate of ammonia alone.

Thus, as far as increase of girth is concerned, sulphate of ammonia has almost as much effect as the full manure. Superphosphate alone has little effect on the increase of girth, which is not surprising, since phosphorus is used by the plant chiefly for the production of seed.

The experiment, however, is not regarded as conclusive, as the soil content of plant food was not known; moreover, the trees may have benefited from the manures applied to neighbouring trees.

The *Journ. Bd. Agric. Brit. Guiana* (1913, **7**, 37) contains a note on a fungus which appears to be a new species and has been named *Passalora heveæ*, Massee. This fungus was found on the leaves of young Hevea trees, where it forms spots which increase in size, producing dried areas which eventually fall away from the green parts, leaving holes in the leaf surface. As preventive and remedial measures the author recommends destroying all affected leaves and spraying with a lime-sulphur wash.

The *Ann. Rep. of the Agric. Dept., Southern Nigeria*, 1912, states that Southern Nigeria is eminently suitable for the growth of *Hevea brasiliensis*. The department has two small Para plantations, of about 3,000 trees each, of a tappable age, one at Agege and the other at Calabar, and it is proposed to carry out extensive tapping experiments. At Agege a number of trees have succumbed to attacks of *Hymenochæte noxia* and *Fomes semitostus*. At Ebute Metta four trees, two *Hevea brasiliensis* and two other *Hevea* species, were tapped on alternate days from June 22 to December 31 by a modification of the half herring-bone system. The two *H. brasiliensis* trees gave 14 lb. 9½ oz. of dry rubber, the other two yielded 13 lb. 4 oz. Thus the average yield was 6 lb. 15⅜ oz. of dry rubber per tree.

General.—The *Gummi Zeitung* (1913, **27**, 1611) describes a mechanical device for tapping rubber trees invented by G. M. v. Hassel. It consists of an apparatus attached to the tree by means of two chains, and possessing tapping knives actuated by springs which are released by means of an electric current. The current is supplied by means of a small dry battery in a central place, from which any number of trees fitted with the apparatus may be tapped simultaneously by a single person.

FIBRES

Silk.—An account of the efforts to improve the silk industry of Bengal is given in the *Rep. Dept. Agric., Bengal, for the year ending June* 30, 1912. In order to obtain a supply of disease-free seed for distribution, nineteen nurseries or rearing houses have now been established, each of which has a mulberry plantation attached to it. The three chief breeds of Bengal silkworms, Chotapalu, Nistari, and Barapalu, are all multivoltine breeds, whilst those of China, Japan, and Italy are univoltine. In order to improve the character of the Indian silk it was suggested by Mr. Lefroy, the Imperial Entomologist, that attempts should be made to hybridise European univoltine worms with the best Indian multivoltine races. For the purpose of carrying out this work, the services have been secured of a European expert who has been specially trained in Mendelian principles. Some hybridised seed has already been produced and distributed to rearers, and the results of the experiments are being awaited with considerable interest. Italian mulberry is being cultivated with success and has been found to prevent "grasserie." Special instruction is provided at the Miraanj Sericicultural Station and at the Sericicultural School at Rajshahi.

A report on the silk farm at Peradeniya, Ceylon, has been published in the *Tropical Agriculturist* (1913, **40**, 350). The farm has been under the management of the Salvation Army for about 2½ years. It consists of about 7 acres, the whole of which has been planted with various kinds of mulberry. The following kinds of silkworms have been cultivated: (1) French univoltine; (2) Indian varieties of the mulberry silkworm, viz. Barapalu, Nistari, and Mysore; and (3) eri silkworms, which feed on the leaves of the castor oil plant. It is also proposed to carry out experiments with the Muga silkworm; the silk of this variety is unknown in European markets, but is readily saleable in India. Arrangements are in progress for the establishment of a silk-mill in Colombo, where the silk will not only be reeled, but twisted, woven, and dyed. It will thus be possible to give instruction in the Island in all the processes of silk manufacture.

New Zealand Hemp.—It was pointed out in this BULLETIN (1907, **5**, 45) that an endeavour was being made to re-establish the fibre industry in St. Helena, with the assistance of the Government. In 1908 a fibre-mill was established and an account of the operations of this mill and the progress of the industry are recorded in *Colonial Reports, Annual No.* 756, *St. Helena, Report for* 1912 [Cd. 6667-4]. In 1912, 1,202 tons of *Phormium tenax* leaves were treated, with the production of 114½ tons of fibre and

35 tons of tow. The fibre realised an average price of £25 17*s*. per ton and the tow £16 3*s*. per ton, and the year's working resulted in a profit of £282, or £462 if the value of that portion of the crop on hand at the end of the year is included. It is considered that the industry has now advanced beyond the experimental stage and that it is in a condition to be undertaken by private enterprise and capital. It is probable that a local firm will shortly erect a mill, but this, on account of its situation, will not affect the western part of the island, where the need and possibility of development are greatest.

Carludovica palmata.—In a recent note in the *Philippine Agric. Rev.* (1913, **6**, 253), M. M. Saleeby refers to an experiment made in the Philippines with *C. palmata*, a plant which grows in shady places in Panama and in the coast regions of Ecuador and Colombia. This plant bears fan-shaped leaves about 4½ ft. in diameter, which are employed for the manufacture of panama hats. The method of preparing the leaves is described as follows: The leaves are cut before they are expanded, and the woody ribs, or stiff parallel veins, are removed. The leaf is then slit into narrow strips, which remain attached at the stalk end. These strips are immersed in boiling water for a short time, and are afterwards dried and bleached in the sun. When completely dry, the strips roll up into a straw-like form, and are then bleached in preparation for hat-weaving. *C. palmata* is now cultivated in Java, and hats are being woven by the women and children, and it is stated that the Java panama hat compares favourably with the common grades made in Panama. The conditions in the Philippines appear favourable to the growth of the plant, and the natives excel in the art of hat-making. It is, therefore, considered that the panama hat industry could be established with success in those provinces in which hat-weaving is the chief household industry.

Paper-making Materials.—In *Bulletin* No. 38, 1913, *Forestry Branch, Dept. of the Interior, Canada*, entitled "Forest Products of Canada, 1912: Pulpwood," an account is given of the pulpwood industry in the Dominion during 1912. The amount of pulpwood cut was 1,846,910 cords, of which 866,042 cords were converted into pulp in Canada, whilst the remainder was exported to the United States. There were 48 mills in active operation during the year, and the quantities of wood consumed in the different Provinces were as follows: Quebec, 578,855 cords; Ontario, 173,903 cords; New Brunswick, 52,041 cords; British Columbia, 35,067 cords; Nova Scotia, 26,176 cords. Of the total quantity, 677,747 cords consisted of spruce; 164,587 cords of balsam fir; 19,178 cords of hemlock; 4,405 cords of poplar; 85 cords of larch; and 40 cords of pine. As much

as 57·6 per cent. of the wood was converted into groundwood pulp by the mechanical process; 33 per cent. was treated by the sulphite process; 7·7 per cent. by the sulphate process; and 1·6 per cent. by the soda process.

Cotton

Sudan.—In an article in this BULLETIN (1913, **11**, 192) it was mentioned that a large quantity of cotton is exported from the Sudan in the unginned state. This cotton has hitherto been consigned to Egypt for ginning. It is stated, however, in the *Reports on the Finance, Administration, and Condition of the Sudan*, 1912, vol. ii., that during the present year (1913) the Egyptian Government are prohibiting the importation of unginned cotton from the Sudan in order to prevent admixture of seed. In future, therefore, all cotton grown in the Sudan will be ginned before export. The excellent results obtained at the Tayiba Experimental Station in the Gezira (this BULLETIN, 1913, **11**, 190) have led to numerous applications for plots of land from the surrounding villages. The above-mentioned report gives a detailed account of the Tayiba experiments and also of those carried out at Tokar. An Ordinance ("The Cotton Ordinance, 1912") has been enacted with the object of improving and maintaining the quality of Sudan cotton, and provides for the issue of regulations with regard to the seed to be sown, the picking of the cotton in a clean state, free from leaves, capsules, and dirt, the destruction of the cotton plants at the end of the season, the ginning of cotton, the licensing of ginneries, and other matters connected with the control of the industry.

Southern Nigeria.—The cotton industry of Southern Nigeria continues to make satisfactory progress. In the *Ann. Rep. Agric. Dept. for the year* 1912, it is stated that 39,043 cwts. of cotton were exported during the year, and that the crop in the Western Province in 1913 will probably exceed all previous records. The Ishan native cotton, which is regarded by the British Cotton Growing Association as the most satisfactory type produced in any part of West Africa, has again given good returns, and 2,796 lb. of selected seed were distributed to farmers in the Ibadan district. The native varieties of cotton growing at the Moor Plantation were affected with a disease which has not yet been identified. Hybridisation experiments have therefore been made with the Ishan and five American varieties with a view to establishing a form combining the good qualities of both these types with a greater resistance to disease than is possessed by the cottons now grown in Southern Nigeria.

Ceylon.—An experiment has been made at Ambalantota on the cultivation of the American Upland cotton known as "Allen's Long Staple." According to the *Tropical Agriculturist* (1913, **40**, 315), a yield of 1,043 lb. of seed-cotton was produced per acre, which is the largest yield yet obtained in Ceylon. The cotton was very clean, of silky appearance, fine, and 1¼ to 1½ in. long. In view of this encouraging result, it is probable that during the next season about 200 acres will be planted in the Hambantota District.

Jamaica.—Although the efforts made during the last ten years to establish cotton growing on a large scale in Jamaica have not met with success, a useful industry is now being developed among the small holders in the Vere district. In the *Ann. Rep. Dept. Agric., Jamaica, for the year ended March* 31, 1913, it is stated that Sea Island cotton was exported during the year to the value of £2,727. Almost the whole of this was produced at Vere, where 500 acres are now under cultivation. The new industry has fortunately been free from the persistent attacks of the cotton worm, which caused so much damage during 1904–7.

FORESTRY AND FOREST PRODUCTS

Afforestation of Sand Hills.—The afforestation of the sand hills of Nebraska and Kansas is discussed in *Bulletin* No. 121, 1913, *Forest Service, U.S. Dept. Agric.* The sand hill regions comprise a total area of 15,000 square miles, nearly one-tenth of the combined area of the two States; they are unfitted for agriculture in their present condition, and are therefore very suitable for afforestation purposes. Nebraska and Kansas have only a small proportion of natural forest land, and produce practically no soft timber. Thus the planting of these regions will not only improve the character of the soil and provide wind-breaks for the fertile agricultural lands to the east, but also assure a future supply of lumber for these States when that of the North-West becomes depleted. The problem of afforestation here is simpler than that of coastal dunes, since in these hills there is very little shifting sand, and the native vegetation, consisting chiefly of grasses, quickly takes possession of new dune formations. After careful experiments it has been found that in Nebraska the Jack, Western yellow, Scots, and Norway pines have succeeded best; whilst in Kansas, where planting has been in progress a much shorter time, and hence the adaptability of species is not so definitely proved, the drought of 1911 has shown the green ash, Western yellow pine, honey locust, and red cedar to be the most resistant trees. The general considerations which make for the greatest success in sand-hill planting appear to be the use of well-grown,

seasoned transplants raised in adjacent nurseries, together with planting in the early spring, immediately after the frost, when the soil is moist.

The Forest Flora of the Gold Coast.—*A List of Trees, Shrubs, and Climbers of the Gold Coast, Ashanti, and the Northern Territories* (London: Waterlow & Sons, 1913), prepared by Mr. T. F. Chipp, has just been issued. The list is preliminary, and includes only those species actually encountered by the author in the course of his work as Assistant Conservator of Forests. The plants are arranged in systematic order, the botanical and native names of each species being given, together with particulars of the herbarium specimens examined, and short economic notes. The list is well furnished with indexes. The work, though primarily intended for the use of forest officers, will also be of use to all interested in the natural resources of the country.

Timbers

Malayan Timbers.—It is estimated that there are at least one hundred useful kinds of timber-yielding trees in the forests of the Malayan Peninsula, and in order to facilitate their identification, by forest officers and others, the Conservator of Forests has in preparation a series of notes which will be published from time to time as data become available. Two instalments have been received recently at the Imperial Institute (*Trees and Timbers of the Malay Peninsula*, Part I., April 1911; Part II., December 1912), and these deal with species belonging to the genera Balanocarpus, Afzelia, Shorea, Durio, Artocarpus, Dyera, Fagræa, Melanorrhœa, Slœtia, Oncosperma, Quercus, Sindora, Cratoxylon, and Casuarina. Many of these species yield valuable timbers that are employed locally, but, with the exception of chengal (*Balanocarpus* spp.), are not exported.

The notes supply information as to the distribution of the trees and their appearance in the forest, and special attention has been given to the barks, on the taste, smell, or appearance of which the Malays mainly rely for purposes of identification. The character, weight, and principal local uses of the woods are also stated, and the photographs of sections of the woods, enlarged three diameters, are intended to assist their identification. In most cases a detailed botanical description of the trees is quoted from an authentic source, and where possible photographs of the trees *in situ* accompany the descriptions.

The Assam Tea-box Industry.—Reference to the tea-box industry of Assam has been made already in this BULLETIN (1911, **9**, 311). An account of the investigations into the industry which formed part of the programme of research

work at the Forest Research Institute, Dehra Dun, for the triennial period 1910–13, is given in *Indian Forest Records* (1913, **5**, 1). Upwards of thirty species of timber are utilised for the locally made tea-boxes, by far the most important of these being nam-dela (*Duabanga sonneratoides*), tulla or bhelu (*Tetrameles nudiflora*), simul (*Bombax malabaricum*), and dumboil (*B. insigne*). Fairly large supplies of these timbers are thought to be still available, but practically everywhere in the neighbourhood of the saw-mills they have been exploited, and now have to be brought considerable distances from the forests, which renders the cost of extraction excessive. The Cachar and Sylhet Divisions, where most of the local hand-sawn tea-boxes are made, obtain their supplies from the Unclassed State Forests of Cachar and Sylhet and from the Lushai and Manipur Hill tracts. In the year 1910–11 the outturn of locally made tea-boxes of all sizes in the various divisions was 834,952. The number of tea-boxes imported into India in 1911–12, so far as can be ascertained from the returns available, was 1,869,841, valued at Rs. 44,72,998 (£298,200), an increase of nearly 100 per cent. in five years. This increase is in part due to the expansion of the tea industry, but is also largely a result of the increased tendency on the part of planters to use imported shooks in preference to the locally made tea-boxes. The difficulty with the local tea-box is that the timber of which it is constructed is liable to be attacked by insects, and if incompletely seasoned is liable to corrode the lead used for lining the boxes and to "taint" the tea. Experiments have been started at the Forest Research Institute with a view to devising a cheap and simple method of treating tea-box timber in order to render it immune from insect attacks and at the same time harmless to the contents of the boxes. Details of these experiments are given, but as they are not yet completed it is too early at present to state that they will prove successful. With a view to increasing the supply of simul timber, from which about 80 per cent. of the local tea-boxes are made, it is suggested that certain areas on the north bank of the Brahmaputra, in the Lakhimpur Divisicn, be reserved and protected, as it is thought that the crop of simul seedlings would then be sufficient within a few years to fully stock these areas.

Railway Sleepers of Pyinkado (*Xylia dolabriformis*).—The possibility of exporting pyinkado sleepers from Burma for use on the Indian railways is discussed in a note which appears in the *Indian Forester* (1913, **39**, 256). So far only a small number of pyinkado sleepers have been exported, and this is due, not to an insufficient supply of the timber, but to other causes, the more important of which are: the difficulty of extracting pyinkado, as it will not float:

the want of lines of communication other than streams; the demand for cheap sleepers by the Burma railways; the cost of conveying railway sleepers to Rangoon; and the high price obtainable in Burma (especially in Rangoon) for pyinkado scantlings and rafters.

Recently the Upper Burma Wood Company have commenced to extract pyinkado from the Yeni Reserve in the Pyinmana Division, and, in this connection, a tram line 12 to 14 miles in length has been laid down between the forest and Ela, at which latter place an up-to-date saw-mill has been erected. It depends much on the success of this undertaking whether the pyinkado business expands or not in the next few years.

The local up-country price for middle-gauge pyinkado sleepers of the first quality is Rs. 1-12 each, or roughly Rs. 56-8 per ton, and for second-quality sleepers Rs. 1 each. The prices for pyinkado rafters, scantlings, boards, and planks in Rangoon are from Rs. 75 to Rs. 80 per ton (January 1913), calculated at 50 cubic ft. per ton. Estimating the cost of broad-gauge sleepers at Rangoon on this basis, their value would be Rs. 5 each, or about as much as the railways would pay for them landed in India. The present price of pyinkado is therefore almost too high to make sleeper extraction profitable.

Should the Burma railways be able to supply all their requirements during the next few years at the local price of Rs. 1-12 per sleeper, it is not improbable that they will reconsider their freight charges for pyinkado, which, owing to the weight of this timber, are at present rather high. In this event the local prices for converted pyinkado timber in Rangoon would fall, and should the sleeper-timber price in India remain as at present, or advance, it is thought the export of pyinkado broad-gauge sleepers from Burma might become a profitable undertaking

Greenheart.—A description of this important timber tree is given in *Circular* 211, 1913, *Forest Service, U.S. Dept. Agric.* Greenheart (*Nectandra Rodioei*, Hook.) occurs over an extensive area on the mainland of South America, and in the West Indies; but it is only worked in British Guiana, where it forms the second most important article of export. Greenheart is unsurpassed for certain purposes; its immunity from the attacks of the teredo under water, and of white ants on land, rendering it of special value in connection with ship and dock building, the construction of bridges, etc.

Walnut.—An account of the Circassian or English walnut (*Juglans regia*, Linn.), which yields one of the best-known cabinet woods on the European and American markets, is given in *Circular* 212, 1913, *Forest Service, U.S. Dept. Agric.* From very early times it has had a most extensive

use, and the demand for it has always exceeded the supply. Most of the present supplies of Circassian walnut come from the shores of the Black Sea *via* Odessa, though large shipments are made from India. The tree adapts itself well to varying conditions of soil and climate, and is consequently one of the most widely distributed of commercial timber trees. In the United States the tree is cultivated solely for its nuts, and hence the timber produced is of little importance.

Technical Properties of Timbers.—The results of tests carried out on Western hemlock (*Tsuga heterophylla*) and Western larch (*Larix occidentalis*), to determine their mechanical and physical properties with a view to their more extensive utilisation, are given respectively in *Bulletins* Nos. 115 and 122, 1913, *Forest Service, U.S. Dept. Agric.* The tests were similar to those carried out by the Forest Service on structural timbers, previously noticed in this BULLETIN (1913, **11**, 358). In the case of both trees the test material employed was of two classes. Structural timbers, chiefly in the form of bridge stringers, with those defects commonly found in timber purchased on the market, were tested to determine the strength, and the effects of seasoning and of defects on the strength, and to compare the efficiency of grading rules and specifications; whilst small, clear pieces were used to study the influence on strength of weight, moisture, and rate of growth. The results of the tests show that the Western hemlock is suited for use in all but the heaviest constructional work, whilst both timbers are well adapted for building purposes, especially for framing, flooring, and inside finishing. In both *Bulletins* the results of the tests are tabulated and discussed.

Tanning Materials

Chestnut.—Attention is directed in the *Leather Trades' Review* (1913, **46**, 597) to the gradual disappearance of the chestnut tree from France. In 1882 this tree covered an area of 356,000 hectares, but the area has diminished since then by from 60,000 to 70,000 hectares. This diminution is ascribed chiefly to the considerable development in the manufacture of tanning extract, which accounts for a decrease of 1,400 hectares annually, and to the disease of chestnut trees known as "ink," or "blackfoot," which has occasioned the disappearance of chestnut trees over a surface of 4,000 to 5,000 hectares.

In some districts this has led to good results, for it has brought about an appreciable advance in the value of the land, due to the substitution of the culture of other more remunerative products than the chestnut. On the other hand, this disappearance has been unfortunate for those districts where the soil is unfit for more remunerative

crops, and where the land has been cleared to such an extent that the surface soil has become washed away.

The conservation and extension of the chestnut forests are necessary for the production of the fruits, which are used in confectionery and as food, for the supply of raw material for the manufacture of tanning extract, for the consolidation of mountainous lands, and for increasing the value of otherwise unproductive lands.

The following measures, among others, have been proposed to remedy the present state of the chestnut forests: That all unproductive lands be planted with chestnut trees; that the chestnut forests be exploited judiciously and then re-stocked with carefully selected plants; and that bounties be offered for forestation with chestnut.

Mangrove.—Reference to the mangrove industry of Mozambique has been made already in this BULLETIN (1905, **3**, 351; 1907, **5**, 59; 1913, **11**, 171). Further information is given in the *Journ. Roy. Soc. Arts* (1913, **61**, 976), where it is stated that the trees are felled when between fifteen and twenty years old, and are logged to standard lengths varying with the diameter, *e.g.* 7 in. trees to 7 ft. lengths; 8 in. trees to 8 ft. lengths, etc. The bark is then stripped off, thoroughly dried, broken into chips, and finally packed in bags for shipment. If the mangrove trees are cut down a few feet above the ground they grow up again, while, if the tree is stripped of its bark without felling, it dies down.

Synthetic Tannin.—Eitner's experiments with "Neradol" (cf. this BULLETIN, 1913, **11**, 360) are described in the *Leather World* (1913, **5**, 699). He found this product to have a slightly acid reaction, which caused swelling in hides immersed in its solution. The tanning action depends but little on the concentration of the liquor, while strong solutions do not cause contraction of the grain. Details of working methods are given. It was found that thick hides could not be completely tanned with "Neradol" alone, but success was attained with lighter skins, especially those of loose texture, such as sheep skin. It can, however, be used for the fore-tannage of sole leather. "Neradol" is stated to accelerate tannage, improve the quality of the leather, give increased density, resistance, and weight, and to have a bleaching effect when used in conjunction with vegetable tanning materials. Eitner does not consider that this synthetic product is likely to replace vegetable tanning materials, but that it can serve as an excellent auxiliary.

Teri Pods.—The results of analyses carried out in the United States on "Teri" pods (*Cæsalpinia digyna*) show that the pod-cases examined contained 42·6 per cent. of

tannin and 18·4 per cent. of non-tannins (*Journ. Soc. Chem. Ind.* 1913, **32**, 500). These pod-cases were therefore slightly less rich in tannin than most of the samples of this product examined at the Imperial Institute (see this BULLETIN, 1912, **10**, 220). It is further stated that the leather given by this material is equal in colour to that from the best sumach, and does not darken appreciably on exposure to light for four weeks. It is recommended that the pods be leached whole, as it is considered that it will not pay to remove the seeds.

Wattle Bark.—The question of growing wattle trees in Western Australia has been taken up recently by the Woods and Forests Department of that State (*Ann. Rep. Woods and For. Dept. West. Aust.*, 1911–12, p. 4), and about 30 acres at the Ludlow Plantation have been sown with the seed of the broad-leaved golden wattle (*Acacia pycnantha*). A few experimental plantations had previously been formed with the purpose of encouraging settlers to plant the useless portions of their land with wattle, but so far no private landowners have done so. In various parts of the State there is land with poor soil where the conditions are favourable for wattle cultivation, and where the tree could be grown profitably. It is claimed that a successful plantation would produce 5 tons of bark per acre when the trees were fit for stripping, that is, when five or six years old, and that this yield would give a return of £25 per acre.

According to the *Leather Trades' Review* (1913, **46**, 630), an experimental consignment of 500 tons of wattle bark has been shipped from Natal to the United States, with the object of finding another market for the bark, which so far as Europe is concerned is at present almost exclusively used in Germany.

Resins

Indian Olibanum or Frankincense.—Previous experiments in tapping *Boswellia serrata* trees, the source of Indian olibanum, in the hot season, having given unsatisfactory results, fresh experiments have been made during the cold weather in the Siwalik Division of the United Provinces, India, particulars of which are given in the *Indian Forester* (1913, **39**, 196). The cold season was selected because it is in this part of the year that the gum-resin is collected in those districts which produce commercial supplies.

The trees were tapped by cutting a ring all round the trunk down to the wood, at a height of 5 ft. from the ground, and about one-half to two-thirds of the bark was shaved off below for a foot in width. Little gum-resin exuded from the first cut, but an improved flow was obtained on two occasions when the wounds were renewed. The yield per tree was found to vary considerably, but

old, faulty trees with thick bark generally gave the highest yield. As a rule the best flow was obtained from the sunny side of the trees. It is concluded from these experiments that the ring of bark shaved off in the first instance need not be more than 3 or 4 in. wide, and that trees exude most gum-resin from old wounds. Gently hammering the bark above the cut seemed to slightly increase the flow. It is stated that this method of tapping cannot be the best, and that further experiments on the subject are required before definite recommendations can be made as to the time and method of tapping.

Lac.—The inoculation of "Kon" trees (*Schleichera trijuga*) in Ceylon with brood lac (see this BULLETIN, 1913, **11**, 360) has not been very successful owing to the insects having emerged from the infested sticks while in transit, and to the considerable damage done by pests (*Trop. Agric.*, 1913, **40**, 277). A sample of the resulting stick lac was reported by the Imperial Entomologist of India to be damaged mainly by predaceous caterpillars, and a living larva of *Enblemma coccidifraga* was found in the tunnels formed in the lac. Only a few cells were unaffected. A further cause of damage was stated to be a minute Hymenopterous parasite (*Chalcidæ*). Both these insects are known to cause damage at Pusa, especially in the June-October crop, the October-June crop being comparatively immune. The same conditions will probably prevail in Ceylon, but as the cultivation of lac spreads it is expected the damage from these causes will diminish.

It is suggested by the Imperial Entomologist that the inoculated trees be occasionally inspected, and all caterpillars destroyed in their tunnels, and in the pustule-like cocoons among the lac.

Turpentine.—The oleo-resins obtained in the course of tapping experiments on the Western pines of the United States (see this BULLETIN, 1913, **11**, 361) have been examined as to their chemical constituents, and the results of this investigation have been published in *Bulletin* 119, 1913, *For. Serv., U.S. Dept. Agric.* Although none of the oils obtained by the steam distillation of the oleo-resins agrees entirely in composition with standard American turpentine oil, there is no reason to doubt that these oils will serve for various industrial purposes.

The oil from the Western yellow pine of Arizona (*Pinus ponderosa scopulorum*, Engelm.) most nearly conforms to standard turpentine oil, and consists chiefly of α-pinene. It is thought that this oil and that from the Western yellow pine from California (*P. ponderosa*, Laws), which consists mainly of β-pinene, could be used as substitutes for ordinary turpentine oil, but practical tests are necessary to decide this point.

The oil from *P. edulis*, Engelm., contains cadinene, but this can be removed by re-distillation, the resulting oil consisting almost entirely of α- and β-pinene. The re-distilled oil is very similar to ordinary American turpentine oil, but it still retains the characteristic odour of the cadinene residue, which might prove objectionable to the user. Digger pine (*P. Sabiniana*, Dougl.) yields an oil quite different from ordinary turpentine oil, and could not be used as a substitute for it. It consists almost entirely of heptane, and might be used in various industries as a cheap and useful solvent. Lodgepole pine (*P. contorta*, Loud.) and sugar pine (*P. Lambertiana*, Dougl.) give such small yields of oleo-resin that their volatile oils are not likely to become commercial products. The constants of the rosins from these various pines are also quoted in this *Bulletin*, but technical trials are necessary to determine whether they can be used in place of ordinary pine-rosin.

The possible markets for Indian rosin and turpentine oil, manufactured at the Government distillery, Bhawali, near Naini Tal, United Provinces, are discussed in a Report forwarded to the *Indian Trade Journal* by the Assistant Conservator of Forests, Naini Tal Division (1913, **29**, 260). Indian turpentine oil has, at present, the disadvantage of leaving a sticky residue, which causes the oil to dry slowly, and prevents it from replacing the American variety in the Indian markets. This residue is attributed by the author to the high temperature of distillation of the crude oleo-resin, and it is intended in future to use steam only for the distillation, and to redistil the oil thus obtained. The investigations made at the Imperial Institute on this oil, however, showed that the oil consists largely of a high boiling part, which oxidises very readily, forming syrupy products, and that whilst steam distillation and a re-distillation will improve the oil, there is no hope of getting rid of this part except by numerous re-distillations and sacrificing a large proportion of the oil (see this BULLETIN, 1912, **10**, 542).

As regards the markets for rosin, already contracts have been arranged for supplying certain paper-mills and soap-factories, while a consignment sent to varnish manufacturers has been reported on as satisfactory. It is stated that, as in the case of Indian turpentine oil, the question of a suitable packing material for the Indian rosin is a factor which to some extent prevents its more extended use. Wooden barrels and boxes will probably be found satisfactory.

Besides this distillery at Bhawali, which can work 100,000 maunds of oleo-resin annually (1 maund = 82·28 lb.), a new one is shortly to be started at Tanakpur, capable of working 20,000 maunds of oleo-resin per annum, while that

at Lahore, which, up to the present, has been more or less experimental, will be developed in the near future, so as to treat 50,000 maunds of crude oleo-resin annually. It is considered, however, that with a growing Indian demand it is doubtful if there will ever be any available surplus for export.

ECONOMIC MINERALS

Gold.—In *Geological Survey, Bulletin* No. 2, 1913, *Southern Rhodesia*, H. B. Maufe, the Director of the Survey, gives an account of the association of gold deposits with acid igneous rocks in Southern Rhodesia. A large part of the territory consists of metamorphic rocks (schists, etc.), which lie in elongated belts of varying width flanked by broad masses of granite.

The rocks of the schist belts may be divided into three series, viz. (1) a series comprising greenstones and greenstone schists, banded ironstone with subordinate phyllites and limestones, and a group of conglomerates and grits; (2) a series of ultra-basic intrusions now represented by serpentine and talc schists, which contain chromite and asbestos; (3) a series of acid intrusions of varied character, consisting in the main of felsite or quartz porphyry, but frequently altered to a schistose condition.

Gold ores are found in each of these three series of metamorphic rocks, as well as in the granitic intrusions; but the results of work done up to the present appear to indicate that the ores are more particularly associated with the third series of metamorphic rocks mentioned above, *i.e.* the felsitic type. The distribution of two important groups of gold-reefs points to the existence of a probable genetic relation between the gold ores and the felsites. If this relation can be definitely established, a knowledge of it will be of importance to the prospector as a guide to the most likely areas of gold occurrence.

Iron Ore.—The Mines Branch of the Canadian Department of Mines has published a report by G. C. Mackenzie dealing with the magnetic iron sands of Natashkwan in the county of Saguenay, Province of Quebec (No. 145, Ottawa, 1912). These sands constitute one of the most promising of the black sand deposits of the Gulf of St. Lawrence. The treeless dune area at Natashkwan has been proved to contain at least 500,000 tons of magnetic iron ore concentrates, averaging 67 per cent. of metallic iron.

The ratios of crude sand to magnetic concentrate in the dune area were found to be about 10 to 1 for a concentrate containing 67 per cent. of iron, and 13 to 1 for a concentrate with an iron percentage of 70. From a crude sand containing 14·7 per cent. of iron and 4·43 per cent. of titanic acid, a concentrate containing 70·4 per cent. of iron and 1·7

per cent. of titanic acid can be prepared, and about 45 per cent. of the original iron is saved in the production of this concentrate.

The method proposed for the working of these magnetite sands is a combination of bucket dredges with Gröndal magnetic separators. An estimate is given of the cost of the plant that will be required to work the deposits by these means; and it is estimated that the cost of iron ore briquettes at Natashkwan harbour will be \$2·7 per ton with a yearly output of 100,000 tons.

Monazite.—In a report by Messrs. E. Masillamani and I. C. Chacko, State Geologists of Travancore, dealing with work done during the years 1907-10, reference is made to the occurrence of monazite in that State.

The rocks of the State are almost wholly gneissic, the only exception being a narrow strip along the coast which is occupied partly by alluvium and partly by the sediments of the Varkkallai (Warkilli) series. This series is of Tertiary age; it is dominantly arenaceous, but includes some clay beds and also a bed of lignite.

Monazite occurs sparingly in the gneisses, but is more abundant in the veins of pegmatite that traverse them From an examination of the alluvial deposits derived from the Varkkallai series, Mr. Chacko infers that the sediments of this series also carry monazite, which might be expected seeing that these sediments have been derived from the underlying gneisses. Confirmatory evidence that the Varkkallai beds contain monazite is provided by the result of an examination of a sample of ash obtained by burning the lignite that occurs in this series. A sample of this ash was examined at the Imperial Institute during the early part of 1910, and was found to contain monazite.

It is of interest to note also that at several places on the beach between Varkkallai and Anjengo there are accumulations of monazite sand that appear to have been formed by the disintegration of cliffs of the Varkkallai sediments.

Travancore thus furnishes a close parallel with Brazil, where monazite occurs in the gneisses of the interior as well as in sediments that form cliffs along the coast. In both cases the sediments forming these cliffs are being disintegrated by marine denudation, and the monazite is being naturally concentrated on the beaches by wave action.

The most important deposit in Travancore, north of Trivandrum, is stated to be that at the Ashtamudi Bar, where the sands are brought down by the Kallada river. The deposits at Cape Comorin are stated to be derived by disintegration direct from the gneisses.

According to the Director of the Geological Survey of India (*Rec. Geol. Surv. India*, 1913, **43**, 91), monazite has now taken an important place in the list of minerals of

economic value produced in India. At present Travancore is the only locality in India where it is being worked. The output rose from 832 tons, valued at £24,044, in 1911, to 1,135 tons, valued at £41,419, in 1912. The mineral occurs as a constituent of the beach sands, from which it can be readily concentrated. For an account of the composition of monazite sand and monazite of Travancore, see this BULLETIN (1911, **9**, 103).

Phosphates.—In *Survey Department Paper* No. 30 (Cairo: Government Press, 1913), Dr. J. Ball gives a brief account of the phosphate deposits of Egypt.

Phosphate rock occurs in various parts of the deserts of Egypt, in sedimentary strata of Upper Cretaceous age. The chief localities where phosphate beds have been found are: (1) The Safâga District, near the Red Sea coast, about latitude 26° 30′; (2) the Nakheil District, near the Red Sea coast, about latitude 26° 10′; (3) the Qurn District, on the east side of the Nile, about latitude 25° 50′; (4) the Sibaia District, on both sides of the Nile, about latitude 25° 10′; (5) the Hamama District, east of the Nile, about latitude 26° 20′; (6) Kharga Oasis, in the Libyan Desert, 200 km. west of the Nile, about latitude 25° 30′; (7) Dakhla Oasis, in the Libyan Desert, 350 km. west of the Nile, about latitude 25° 40′.

Of these occurrences, two are being worked, viz. those of the Safâga and Sibaia districts. Up to 1912, Egypt's output of phosphate was small, and was all derived from the Sibaia district. Since then the output of the Safâga mines has become established, and these mines are now an important source of phosphate.

The mining of phosphate in Egypt began in 1908, in which year there was an output of 700 tons. In 1911 the output had grown to 6,425 tons, but in 1912 it reached 69,958 tons, and Egypt promises to become an important contributor to the world's production of phosphate. The phosphate is at present exported in a raw state, as there is no factory for the manufacture of superphosphate, and there is little or no local demand for the product. Should a local demand for raw phosphate arise, there appears to be plenty of material available for use that is rather too low-grade in quality for export.

In *Survey Department Paper* No. 29, Dr. Ball deals with the topography and geology of the phosphate district of Safâga, which is at the present time the most important of the various Egyptian phosphate districts enumerated above.

The Safâga deposits occur on either side of the Wadi Safâga, at distances from 12 to 22 km. inland. They occur in several isolated areas, of which the three principal are those of Um el Huetat, Mohammad Rabah, and Wasif.

The oldest rocks of the district are the fundamental granites, greenstones, etc. These are succeeded by Nubian sandstone, and overlying the latter there are Cretaceous and Tertiary sediments. The sedimentary rocks occur in basin-shaped depressions and are surrounded by hill masses made up of the igneous rocks. The areas covered by the sedimentary strata are approximately as follows: Um el Huetat, 60 sq. km.; Mohammad Rabah, 25 sq. km.; Wasif, 36 sq. km.; and it is estimated that the phosphate beds exist over about one-seventh of these total areas.

The phosphatic series of beds is in the Cretaceous; it consists of clays, phosphate, and chert, lying below beds of Upper Cretaceous limestone; and in the Um el Huetat basin, which is typical of the Safâga district, the series has a total thickness of about 45 metres, as follows:

(*a*) Phosphate bed No. 1 (1·8 metres).

(*b*) Chert beds with thin bands of hard phosphate (5 metres).

(*c*) Phosphate bed No. 2 (1·3 metres).

(*d*) Laminated grey clays (9 metres).

(*e*) Phosphate bed No. 3 (2 metres).

(*f*) Laminated grey clays (25 metres).

It has been found that the phosphate beds crop out wherever the lower limit of the Upper Cretaceous limestone is exposed, and they show a dip of about 13° towards the centre of the basin, though the dip is variable, being much less in some localities. The important mines are situated near the centre of the Um el Huetat basin.

The results of a large number of analyses indicate that the three phosphate beds contain on the average the following percentages of tricalcic phosphate: No 1, up to 60 per cent.; No. 2, 50 to 75 per cent.; No. 3, 20 to 45 per cent.

Mining operations on an extensive scale are at present confined to the Um el Huetat area, and to the middle or No. 2 bed, the richest of the three. Nearly all the phosphate exported from Egypt since the beginning of 1912 has been obtained from these mines, and at the time the report was written the daily output was about 300 tons of rock, containing 65 per cent. or more of tricalcic phosphate. The mines are connected by a private railway, about 20 miles long, with Port Safâga.

Tungsten Ore.—In a paper "On some Occurrences of Wolframite Lodes and Deposits in the Tavoy District of Lower Burma" (*Rec. Geol. Surv. India*, 1913, **43**, 48), Dr. A. W. G. Bleeck gives the results of two months' field-work among the tungsten-ore deposits of the Tavoy District.

The district is mountainous, with elevations up to 6,000 ft., and the general strike of the ranges is N.N.W.-S.S.E. It is mostly jungle-clad, with high forest and

the Introduction has been carefully examined; many of the sections have been rewritten and corrected by the light of further knowledge; some new sections and maps have been added; the figures of the last census of 1911 have been adopted, wherever available—the general object has been to provide the best and newest information attainable regarding the country and places mentioned, the means of travel, and the sights best worth seeing." In the spelling of place-names, the system adopted—occasionally at variance with spellings on the maps—is admittedly a compromise, but one that, at least, has "official authority."

The introductory information contains general hints for the use of travellers, a description of the outward voyage, and a very valuable summary, giving information—statistical, ethnological, historical, archæological, and material—in regard to the country and its people. Bartholomew's maps and plans, beautifully reproduced, greatly enhance the value of this famous handbook, which is a model of what a handbook should be, as a book of ready reference supplying authoritative information.

Mozambique: Its Agricultural Development. By Robert Nunez Lyne, F.L.S., F.R.G.S. Pp. 352, Demy 8vo. (London: T. Fisher Unwin, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 11*d.*, abroad 13*s.* 11*d.*

This book, which is intended primarily for investors and settlers, appears at a time when much interest is being taken in the development of East Africa—British, German, and Portuguese—and contains much information that will be of value alike to business men and prospective planters. Of the natural advantages possessed by Portuguese East Africa there can be little question. Mozambique (the author performs a useful service in defining the five designations of the word) is favourably circumstanced in regard to communications, transport, and accessibility of markets; and to these fundamental conditions for development may be added, large areas of fertile land situated near the coast and easily irrigated from slowly moving rivers. The author has an instructive chapter on the limiting factor of effective labour. It would appear that sparseness of population is the main cause of the scarcity of labour for agricultural purposes, and it is maintained that the recruiting of men for the Rand does not seriously affect the question for the planter. Contributing causes are the natural indolence of the people and the inexperience of white employers in the management of natives.

Based upon an experience of the country gained during his tenure of the post of Director of Agriculture, the author discusses the prospects of various branches of planting enterprise and gives many useful hints in regard to the

culture of specific crops. Sugar and coconuts are established industries; for the development of the former it would appear that improved methods of cultivation and the use of labour-saving machinery are necessary; while in regard to coconuts the author is of opinion that the present areas planted are not first-class coconut districts. One of the chief problems in the development of the country is the future of rubber-planting. The question is discussed in a conservative spirit, but it would appear that the Ceara plantations of Quelimane and Inhambane are not without promise. The bulk of the rubber exported, however, is derived from the "root" of a Landolphia, probably *L. Kirkii.* The exploitation of the Landolphia forests for both stem and "root" rubber is dealt with, the author discussing the use of machinery for the production of larger quantities of a better-quality rubber. The Matadane forest is stated to be probably the only rubber forest on the east coast of Africa that is systematically worked. Other promising crops dealt with are Sisal, cotton, and tobacco, and there is an account of mafureira (*Trichilia emetica*) and jikungo (*Telfairia pedata*), two oil-bearing nuts already more or less well known. "Native" crops, *e.g.* maize, ground nuts, and rice, are briefly considered, and chapters are devoted to fruit-growing, lucerne, and vanilla. In the chapter on cattle-breeding and dairying it is pointed out that, in the tropical areas, cattle-raising will never be more than subsidiary to the planting industry. The district of Lourenzo Marques, however, is one of the best grazing countries in South Africa, its capacity being estimated at 800,000 head, while the present count is but 45,000 head (cf. this BULLETIN, 1913, **11**, 102). The area is now practically free from serious stock diseases, but in view of its serious consequences for the native cattle-breeder the author strongly criticises the policy of "slaughtering out" that was adopted to combat East Coast fever. For the investor there is useful information in regard to security of tenure in the country, and notes on the labour difficulty and fiscal questions. The main appendix consists of a translation of the Labour Law for the Mozambique Province (1909), and there is a useful map by Stanford.

BY THE EQUATOR'S SNOWY PEAK. By E. May Crawford. Pp. 176, Demy 8vo. (London: Church Missionary Society, 1913.) Price 2*s.* 6*d.* net; post free, United Kingdom 2*s.* 10*d.*, abroad 3*s.* 2*d.*

A record of medical missionary work and travel in, perhaps, the most attractive district—Kenia Province—of British East Africa, under the equator, should make a wide appeal. The author and her husband, Dr. T. W. W. Crawford, had some interesting experiences in the course

of their travels, and encountered many obstacles that were successfully overcome, at Weithaga, Kahuhia, Embu, and in the little known highlands beyond. The period covered was 1904–1912. The account given of the Akikuyu and other tribes is illustrated by some excellent photographs, and there is a coloured frontispiece, giving a view of Mount Kenia; but the block-map is all but useless.

The difficulty of overcoming native prejudice and of combating some objectionable customs—particularly Dr. Crawford's struggle with the witch doctor in Karbuti's village—is shown by the author to be far from insuperable; but much patience, tact, and firmness are required by those who attempt it. In that respect, a medical missionary has an additional advantage; and Mrs. Crawford's schools and Bible classes were well attended.

British Columbia in the Making, 1913. By John Bensley Thornhill, F.R.G.S. Pp. xiv + 175, 8vo. (London: Constable & Co., 1913.) Price 5*s.*; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

This book is avowedly written with a view to awakening interest in British Columbia as a field for the investment of capital. It gives a brief account of the history and development of the Province, and of its geography and climate, and then deals in a series of chapters with the transport facilities, the principal industries, and the possibilities of development.

Though the author has a good deal of criticism to offer regarding the financial side of certain phases of development in the Province, he takes on the whole a very sanguine view of the possibilities of the country. The book is quite useful as a statement of personal views based on actual experience of life under various conditions in the Province.

Twentieth Century Jamaica. By H. G. De Lisser. Pp. 208, 8vo. (Kingston, Jamaica: The Jamaica Times, Ltd., 1913.)

Apart from its general thesis this volume has little in common with the "handbook" that might be suggested by the title. The author has endeavoured to provide a picture of life in Jamaica at the present day, urging that no work on Jamaica, "written with intimate knowledge of the country and its people," has appeared for the last twenty years. The problem of the West Indies is one of great importance, and this book will be read with interest. The ten chapters are in the main concerned with the *people* of the Colony, their life as individuals and their hopes and aims as a community. Not the least interesting is that devoted to local politics and the ways of the Jamaican

politician; the author has broken fresh ground in his vivid description of a tropical election.

The two most important chapters are probably the first and last, dealing respectively with "Jamaica's future with England, Canada, and the United States," and "Evolution and Progress." The author's views are sharply defined and lack no force of expression. He brings forward evidence to show that the darker elements of the population are destined to secure a social and economic position which would have been thought impossible a century ago, and that an improvement in the social and moral conditions of these people depends primarily upon the economic advance of the country. Such an advance is considered to be assured. The invaluable assets of an excellent soil and variety of climate, a fine system of roads, and a settled, industrious population, should be powerful factors in its accomplishment, but the great need is better markets. Canada and the United States are looked to by the author to furnish this *sine qua non*, and the political future of the country thus comes into question. This important matter is discussed in the first chapter, which affords conclusions that are not novel to students of colonial affairs in this country. The book is illustrated by interesting photographs, which, however, are of no special excellence.

THE BRITISH GUIANA HANDBOOK, 1913. Containing general and statistical information concerning the Colony, its industries, manufactures, and commerce. Edited by Alleyne Leechman (of the Department of Science and Agriculture, British Guiana), and issued by the Permanent Exhibitions Committee under the direction of His Excellency Sir Walter Egerton, K.C.M.G. (Chairman). Pp. x+283, 8vo. (Georgetown, British Guiana: "The Argosy" Co., Ltd. London: Dulau & Co., 1913.) Price 2*s.*; post free, United Kingdom 2*s.* 4*d.*, abroad 2*s.* 7*d.*

This volume forms a revised edition of the well-known "Handbook" issued by the Permanent Exhibitions Committee of British Guiana in 1909 (see this BULLETIN, 1910, **8**, 333). In large measure the handbook has been re-cast, and now gives a remarkably concise and well-edited account of the present condition and resources of the colony; it is a book which, if widely distributed, should do much to arouse and advance interest in a comparatively little known country. The handbook as it now stands opens with an admirable introduction to the body of the work, which consists of five sections, dealing respectively with the country itself, its political organisation, resources, and opportunities for touring, while the final section comprises a statistical survey of the trade, finance, and meteorology of the colony, with information as to communications, postal facilities and allied subjects. The individual chapters are based on the

articles contributed by specialists to the handbook for 1909. In the section on the country, the review of the geology of the colony is by Prof. J. B. Harrison, while Mr. F. A. Stockdale has re-written the chapter on climate, this latter article, together with that on hygiene, revealing re-assuring features probably unsuspected by those without personal knowledge of the country. The political section contains a concise statement of the Constitution, illuminated by an instructive "History of the Political Constitution," which traces events down to the changes effected in 1891. Local government, immigration, and education are dealt with, and there is a short chapter on the aboriginal "Buck" Indians. The most important section, viz. that devoted to the resources of the colony, has been revised by Mr. Stockdale. Preliminary chapters deal with the fauna and flora, the former contribution being made by the editor. The succeeding chapters on agriculture, forests, mining, and manufactures afford a most useful survey of the modern industrial condition of British Guiana, and indicate the lines along which development may be expected. The commercial man will find information regarding the ordinance under which Crown Lands may be leased for purposes other than mining, the regulations relating to the mining industries, and a copy of the "Mining (Mineral Oil) Regulations, 1912." There is also a statement in regard to the recent reciprocity agreement with Canada. The book is admirably printed, and reference must be made to the excellent photographs and map. The low price at which the volume is issued has probably stood in the way of a more substantial binding.

GUATEMALA AND THE STATES OF CENTRAL AMERICA. By C. W. Domville-Fife. Pp. 310, Demy 8vo. (London: Francis Griffiths, 1913.) Price 12*s.* 6*d.* net; post free, United Kingdom 12*s.* 10*d.*, abroad 13*s.* 2*d.*

The author of this volume is already well known as an authority on Latin America through his books on *The Great States of South America* and *The United States of Brazil.* In the present volume this survey is continued by descriptions of the Central American States, Guatemala, Nicaragua, Costa Rica, Salvador, and Honduras. In each case a brief account of the history of the country is given, followed by descriptions of its present position, people, scenery, and typical features. Some reference is also made to the agricultural and mining industries of the countries and to their commerce and trade.

The increase in importance of the Central American States, which will be one of the results of the opening of the Panama Canal, will no doubt attract both the general and the commercial visitor to those territories in great

numbers in the near future. To any one proposing to take such a trip, this volume will be of great value, but it should also appeal to all who are interested in the unique problems connected with the political development of these countries.

TWO YEARS WITH THE NATIVES IN THE WESTERN PACIFIC. By Dr. Felix Speiser. Pp. xii+291, Demy 8vo. (London: Mills & Boon, 1913.) Price 10s. 6*d*. net; post free, United Kingdom 10s. 11*d*., abroad 11*s*. 3*d*.

The natives of the Western Pacific visited by Dr. Speiser, and dealt with in this book, were those of the New Hebrides and some outlying islands of the archipelago between Banks Island and Tanna, including a visit to the little-known Santa Cruz Islands. It is a popular account of the routine life of the natives and of the experiences of an explorer who, under most discouraging circumstances, was determined to make their better acquaintance. In this Dr. Speiser succeeded in a remarkable degree; and he gives the reader a very vivid impression of the islands and peoples he visited, no less than an instructive view of the general situation which the Anglo-French Condominium is attempting—with little apparent success—to control. In particular, he lays stress on the laxity or absence of French supervision over methods of recruiting for labour and the liquor traffic; and he gives many instances of the deterioration and decimation of these savages—many of them cannibals—by disease, alcoholism, and contact with degenerate whites. This specially is noticeable on the island of Ambrym, where the natives—originally among the most vigorous and energetic tribes of the archipelago—spend all their money in drink, at least on the French side. "If," says Dr. Speiser, "the liquor traffic is not speedily suppressed, the population is doomed" (p. 201).

There are singularly few lapses of idiom—considering the author is interpreted in a foreign language—while passages descriptive of scenery and the war of the elements in this group of coral and volcanic islands are very effective. Exception may be taken to the use throughout the book of the metrical system of measurement, to which the general reader in this country is not accustomed. In a work otherwise so well illustrated and produced, one would have expected a suitable map, without which it is difficult to follow the author in his wanderings: the rough type-blocks, with German spellings, are all but valueless.

THE CONQUEST OF THE DESERT. By William Macdonald, M.S.Agr., Sc.D., Ph.D., D.Sc., F.R.S.E., F.G.S., Editor of the *Agricultural Journal*, Union Department of Agriculture, South Africa. Pp. xii+197, Demy 8vo. With 50

illustrations. (London: T. Werner Laurie, Ltd., 1913.) Price 7*s.* 6*d.* net; post free, United Kingdom, 7*s.* 10*d.*, abroad 8*s.* 1*d.*

The Kalahari is a desert tract in the centre of South Africa, 120,000 square miles in extent; the greater part lies in the Bechuanaland Protectorate, but the southern portion, extending from the dry bed of the Molopo river to the Orange river, forms the Gordonia District of the Cape Province. It is with this portion that the author deals; he gives an account of his travels in it, and a vivid description of the soil and conditions there. The area is 18,499 square miles, and more than two-thirds is unsurveyed waterless desert. Along the Orange river, and at some places where water is brought by irrigation canals, a good deal of farming is done. The neighbourhood of this river is very suitable for orange trees, and they are grown around Upington, the chief town of Gordonia, and at Kakamas, another irrigation colony. Here and there away from the river, at places where water can be got, there are farms where stock is raised. These farms are of enormous area, being 10,000 to 100,000 acres in extent; land in such places sometimes fetches about a shilling an acre. Water last flowed in the Molopo river in 1894, but was lost in the sand before it reached the Orange river. The existence of this dry river bed shows that the rainfall must formerly have been greater. Notwithstanding the deficiency of rainfall certain plants grow in the desert, such as the "bushman grass," which thrives on a rainfall of 3 to 10 in. per annum, and on which cattle get fat. Another stand-by is the tsamma melon, which affords water and food to the wandering natives and to travellers crossing the desert. The author points out how the conditions might be improved by afforestation, and how the land might support a considerable population by means of the "dry farming" methods of cultivation which are now attracting so much attention all over the world. The author believes that the Kalahari desert is underlaid with water, which can be utilised by boring. Extension of the railway from Prieska, which is 120 miles from Upington, is also needed.

RUBBER AND RUBBER PLANTING. By R. H. Lock, Sc.D. Pp. xi + 245, with 10 plates and also figures in the text, Crown 8vo. (Cambridge: at the University Press, 1913.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

The author of this book was, until recently, the Assistant-Director of the Royal Botanic Gardens at Peradeniya in Ceylon, a position which brought him into close relationship with the rubber-planting industry in the island. During his stay in Ceylon, Dr. Lock carried out, in conjunction with Mr. Kelway Bamber, a long series of tapping experi-

ments on *Hevea brasiliensis*, the Para rubber tree, and was thus able to study the various scientific problems connected with the production of latex and the physiological effects of tapping the trees. The present book deals mainly with the Para rubber tree, and is based very largely on the author's personal observation of plantation methods in Ceylon and the results of his own experiments.

The first two chapters (pp. 1–37) are devoted to the history of the use and cultivation of rubber and to a short summary of the principal rubber-yielding plants, and are followed by two chapters (pp. 38–92) on the important subject of the physiology of latex production. In the latter chapters, which form the most important section of the book, Dr. Lock deals with the structure and functions of the vegetative organs, the different types of laticiferous tissue, the structure of the bark of Hevea, the effects of wounding the bark, bark renewal, etc., and then gives a summary of his tapping experiments on Para trees in Ceylon during the years 1908–12. These experiments related chiefly to the effect of tapping Para trees at intervals of from one to seven days, the points investigated being: the yields of latex and rubber, the duration of the yield, the relation of the yield to the amount of bark removed, the origin of latex, the seasonal variation in the flow of latex, the effects of over-tapping, the effect of tapping on the composition of the latex, etc. Very interesting results were obtained from these experiments, but as the data have been already published in Ceylon, and summarised in this BULLETIN (1911, **9**, 407; 1912, **10**, 495), no detailed notice is necessary here.

Chapters V. to VIII. (pp. 93–196) are devoted to a general account of the methods adopted in Ceylon for cultivating and tapping Hevea trees and for preparing the rubber. The diseases and pests which attack the trees are also described.

The cultivation of rubber-yielding plants other than *Hevea brasiliensis* is dealt with in pp. 197–209, and the remainder of the book (pp. 210–237) is occupied by an account of the chemistry of rubber and the manufacture of rubber goods.

The book gives within a convenient compass a useful account of the production of Para rubber in Ceylon, and also calls attention to the various scientific and technical problems which arise in connection with the rubber planting industry. These problems demand very careful investigation, as they may have an important bearing on the future of the industry, and the results of Dr. Lock's experiments, extending over four years, deserve study from this point of view.

The rubber-yielding plants other than *Hevea brasiliensis* are only very briefly dealt with, and in this section a few

slips have been noticed. The generic names Forsteronia and Mascarenhasia are wrongly spelt both in the text and index; *Funtumia africana* and *Landolphia florida* are mentioned as rubber-yielding plants; and *Funtumia elastica* is stated to have been formerly known as *Kickxia africana*.

THE CHEMISTRY OF RUBBER. By B. D. Porritt, B.Sc. (Lond.), F.I.C., Chief Chemist to the North British Rubber Company, Edinburgh. Pp. vi + 96, Crown 8vo. (London: Gurney & Jackson, 1913.) Price 1*s.* 6*d.* net; post free, United Kingdom and abroad, 1*s.* 9*d.*

This little book can be recommended to all who desire to obtain a concise and trustworthy account of our present knowledge regarding the chemistry of rubber. Within the short limits of 96 pages Mr. Porritt has succeeded in giving an excellent survey of recent researches on the subject, including the work on the production of synthetic caoutchouc. The ground covered includes the properties of crude rubber; the constitution and derivatives of caoutchouc; the methods of vulcanisation and the theories which have been put forward to explain the change; waste rubber and its utilisation; and lastly, synthetic caoutchouc. A very good bibliography, to which references are given throughout the text, adds considerably to the value of the book.

THE PREPARATION OF PLANTATION RUBBER: A reference text-book for practical planters. By Sidney Morgan, A.R.C.S., F.C.S. Pp. x + 269, Royal 8vo. (London: The Rubber Growers' Association; no date.) Price 10*s.* net; post free, United Kingdom 10*s.* 5*d.*, abroad 10*s.* 9*d.*

The cultivation of *Hevea brasiliensis*, the Para rubber tree, on a very extensive scale under plantation conditions in the East, has given rise to a large number of problems connected with the methods of growing and tapping the trees and of preparing the rubber, and in the working of the estates practical difficulties are continually arising. These problems and difficulties demand careful scientific investigation on the spot as the first step for their successful solution, and, realising this fact, the Rubber Growers' Association inaugurated, three years ago, a scheme of research to deal with the questions which were then already arising in connection with the plantation industry. Mr. Sidney Morgan was chosen to conduct the investigations in the Federated Malay States, and the volume now under notice, which records the principal results of his work during the last three years, supplies conclusive proof as to the necessity and value of such research work.

The book is divided into five parts, each dealing with a separate branch of plantation work, viz. (1) field opera-

tions, including systems of planting, thinning out, tapping systems, collection and transport of latex, and general field work; (2) factory operations, including the preliminary treatment of latex, coagulation, preparation of sheet and crêpe rubber, drying and smoking of rubber; (3) machinery and buildings, including suggestions as to the choice of machines, and as to the construction of factories, drying and smoking houses, store rooms, etc.; (4) the finished rubber, including defects in crêpe, block, and sheet, the comparative strengths of the different forms of rubber; and (5) general, dealing with the preparation of pale crêpe as compared with smoked sheet, the comparative qualities of plantation and fine hard Para, the grading of plantation rubber, methods of packing, spraying mixtures and formulæ, soils and manuring.

The book is essentially practical in character, and supplies valuable information to planters on all the various points with which it deals. The sections devoted to the finished rubber will, however, probably be of the greatest general interest, as they include a study of the defects to which plantation rubber is liable, and the results of investigations as to the comparative qualities of the different forms in which plantation rubber is prepared. In the latter case the opinions are based on the results of vulcanisation tests carried out in this country by Messrs. Beadle and Stevens. A few examples of the points investigated with reference to the finished rubber will indicate the practical nature of the work which Mr. Morgan has carried out: the effect on the quality of the rubber of (1) diluting the latex with water, (2) using an excess of acid for coagulation, (3) adding a solution of sodium bisulphite to the latex in order to obtain a pale rubber; the effect on sheet rubber of rolling it soon after coagulation or after allowing it to stand over-night; the effect of rolling on the quality of crêpe rubber; the defects in sheet, crêpe, and block rubber due to stains, oil-marks, mechanical impurities, "spot diseases," or tackiness, etc. On all these topics Mr. Morgan gives very useful information, based on the results of his experiments.

Another very interesting section of the book deals with the comparative strengths of the different forms of plantation Para rubber, and of plantation Para and fine hard Para. On these important points the results obtained indicate that smoke-cured sheet is superior in quality, as judged by mechanical tests, to every other form of plantation rubber, and that, assuming smoked-sheet and pale crêpe to be at the same price, it is more profitable for an estate to produce smoked-sheet than pale crêpe. On the vexed question of the comparative value of plantation Para and fine hard Para the author gives the results of a large number of tests, which show that many samples of

smoke-cured sheet are equal or superior to market samples of fine hard Para.

Mr. Morgan is to be congratulated on this record of very useful work ably carried out. The book is the most important contribution which has yet appeared on the practical details of rubber production from cultivated Para trees, and should be in the hands of every estate manager. The success which has attended this scheme of rubber research, inaugurated by the Rubber Growers' Association, is sufficient to justify its continuance on an extended scale, as such investigations cannot fail to be of the highest importance to the planting industry.

THE RUBBER TREE BOOK. By W. F. de Bois Maclaren. Pp. xvi + 307, with 85 illustrations. Royal 8vo. (London: Maclaren & Sons, Ltd.; no date.) Price 10*s.* 6*d.* net; post free, United Kingdom 11*s.*, abroad 11*s.* 6*d.*

This book forms a further addition to the literature on the subject of the cultivation of the Para rubber tree, and deals in some considerable detail with all the varied questions and operations involved in the working of plantations of the trees, from the acquisition of the land to the sale of the rubber. This is now well-trodden ground, but in his introduction the author states that "an endeavour is at least made to bring new light to bear upon rubber cultivation from various points of view which have hitherto received little or no attention. The endeavour is also made to arouse the interest of the planter in the soil he cultivates and the trees he grows there by showing how varied and wonderful are the phenomena connected therewith. When interest is thus aroused, then work becomes congenial, habits of closer observation are stimulated, and the tendency is, therefore, towards increased efficiency. . . . To assist in obtaining better results than have been secured in the past, to achieve these on more economical lines, and with a greater regard than has hitherto been shown for the future welfare of the rubber-growing industry viewed as a permanent investment, is the object with which this book has been written."

The book has certainly a claim to novelty amongst books dealing with rubber cultivation, in that it is embellished with quotations from, or references to, a large number of authors, including Chaucer, Pope, Wordsworth, Tennyson, Kipling, Darwin, Huxley, Sir Oliver Lodge, "the Hon." A. J. Balfour, Defoe, Disraeli, Oliver Wendell Holmes, Carlyle, and Bergson.

The attempt to interest the planter and his assistants in their work is also made on novel lines. The assistant in a rubber factory is thus addressed: "Let such an assistant consider a few—a few only—of the facts in front of him. He casts a careless eye upon the iron rubber-washing mill

in front of him. He sees it. Why does he see it? Because the particles of which it is composed vibrate at not less than four hundred billion times a second. Did they vibrate at a slower rate he could not see the mill. Did they vibrate at a rate more than twice as fast the mill would again be invisible. Here have been at once raised a legion of the hows and whys which occupy the constant attention of the greatest scientific minds of the century." Even these questions are, however, not sufficient for our author, who proceeds: "Next let the assistant we have supposed have his attention aroused in this way to consider—What is matter? . . . What is an atom? . . . Thus an intelligent assistant can inspire his daily task." We must confess, however, that we feel a little doubtful as to the number of factory assistants in the tropics who will respond to the stimulus which Mr. Maclaren has so kindly provided for them.

On the general questions of estate procedure and management Mr. Maclaren is more practical, and the information he supplies is usually trustworthy. The book is well got up, and the illustrations are both numerous and good.

The Cabinet Timbers of Australia. By R. T. Baker, F.L.S. No. 18 of the Technical Education Series, Sydney Technological Museum. Published by the authority of the Government of the State of New South Wales. Pp. 186, Crown 4to, oblong, with 68 coloured, and many other illustrations. (Sydney: Government Printer, 1913.)

The author states in his preface to this volume that it was written with the desire to produce among Australians a better appreciation of Australian forest wealth, and also with the object of calling attention to the fact that some of the trees yielding the most beautiful of Australian woods are in danger of being exterminated owing to the rapid advance of the settler and the consequent destruction of forest. The volume should abundantly serve these purposes. It was a happy idea to invoke the aid of colour photography in representing these woods, by which means their beauty and ornamental character are clearly and accurately depicted. The grain and figure of such timbers as Yellow Wood, Crowsfoot Elm, Black Bean, Tulip Wood, Blackwood, and Red Cedar lend themselves admirably to this method of reproduction. There is a concise description of each timber figured, the botany of the tree and its geographical range, as well as a general account of the ornamental timbers of Australia from the cabinet-maker's point of view. There are also numerous illustrations in black and white showing how many of the woods are employed for interior fittings and furniture, though some of these would have been seen to better

advantage in their natural colours. In the final chapters lists of timbers suitable for various kinds of cabinet-work are given, as well as a summary of the characters of the timbers dealt with. These add considerably to the value of the book, which will be welcomed by all interested in timbers and in forest preservation.

THE FERMENTATION OF CACAO, WITH WHICH IS COMPARED THE RESULTS OF EXPERIMENTAL INVESTIGATION INTO THE FERMENTATION, OXIDATION, AND DRYING OF COFFEE, TEA, TOBACCO, INDIGO, ETC., FOR SHIPMENT. Edited by Harold Hamel Smith, with a Foreword by Sir George Watt, C.I.E., M.B., C.M., LL.D. Pp. lvi + 318, Crown 8vo. (London: John Bale, Sons & Danielsson, Ltd., 1913.) Price 10*s.* net; post free, United Kingdom 10*s.* 4*d.*, abroad 10*s.* 6*d.*

This book consists of a series of articles on cocoa fermentation by well-known experts. In a preface by the editor, the source and scope of these various essays is indicated, attention is directed to the by-products of cocoa fermentation and their possible utilisation, and emphasis is laid on the need for Government assistance in financing institutions for giving instruction in the principles and methods of tropical agriculture.

The essays are published in the following order: (1) A translation, which first appeared in *Tropical Life*, of an article by Dr. Axel Preyer in *Der Tropenpflanzer* (1901, **5**, 157). (2) An article by Dr. Oscar Loew, reprinted from *Bull.* No. 1,093, *Office of Experiment Stations, U.S. Dept. Agric.*, which was originally published in the Annual Report of the Porto Rico Experiment Station for 1907. This paper deals with the fermentation of coffee as well as that of cocoa. (3) A translation of an article by Dr. Fickendey, Director of the Experiment Station, Victoria, Kamerun, originally contributed to *Der Tropenpflanzer* (1909, **13**, 87). (4) A translation of an essay by Dr. A. Schulte im Hofe, first published in Berlin in 1908, which, whilst dealing chiefly with cocoa, contains notes on the fermentation of coffee and tobacco. (5) A translation of an article by Dr. J. Sack. (6) A joint essay by Mr. George Hudson and Dr. Lucius Nicholls, which was awarded the prize in a competition arranged under the auspices of *Tropical Life*. The first part of this essay is written from the practical point of view by an experienced planter, whilst the second gives an account of the nature of the fermentative process and the changes which occur during its progress. The whole subject is summed up by the editor in a chapter entitled "The Last Word," and the opinions expressed by the various authors are compared and discussed. This is succeeded by the final chapter, consisting of a few notes by the editor on the curing and fermentation of tobacco.

The volume is well illustrated, and should be of considerable assistance to cocoa planters in enabling them to carry out the preparation of their crops in a scientific manner, and thus ensure their arrival at the factory in a satisfactory condition.

PLANTATION WHITE SUGAR MANUFACTURE. By W. H. Th. Harloff, Manager of the Boedoeran Sugar Factory, Java, and H. Schmidt, Consulting Sugar Chemist and Engineer, Java. Translated from the Second Revised Dutch Edition by James P. Ogilvie, F.C.S. Pp. vii + 138, 8vo. (London: Norman Rodger, 1913.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 9*d.*, abroad 7*s.* 10*d.*

The original Dutch edition of this manual, issued under the title of *Handleiding voor Tropische Witsuikerfabrikatie*, has met with such a cordial reception in Java that it was deemed desirable to extend its circulation among English-speaking sugar producers.

The object of the work is to afford an insight into the practical methods of the manufacture of cane sugar and the machinery required for the purpose, and to furnish an explanation, based on theoretical principles, of the various processes adopted.

The book is divided into two parts, the first giving a brief account of the chemistry of the subject, and the second dealing with the actual operations carried out in the course of manufacture. In the former section, consideration is devoted to the influence of alkalis, alkaline earths, acids, and of heating, on the constituents of cane juice, and reference is made to the colouring matters contained in the juice and those produced during the manufacturing processes, and to the different kinds of fermentation which may occur in the sugar factory. The second part of the book discusses the two methods of clarifying the juice, viz. carbonatation and sulphitation, and the treatment of the concentrated juice and syrups. The various processes are lucidly explained, and many valuable hints are supplied.

The work is written in a clear and interesting manner, and will doubtless prove a valuable aid to sugar manufacturers in tropical countries.

THE VOLATILE OILS. By E. Gildemeister and Fr. Hoffmann. Second edition by E. Gildemeister. Volume I. Authorised translation by E. Kremers. Pp. 667 + xiii, Med. 8vo. (London: Longmans, Green & Co., 1913.) Price 20*s.* net; post free, United Kingdom 20*s.* 6*d.*, abroad 21*s.* 4*d.*

The previous edition of this work, of which the English translation appeared in 1900, has long been considered one

of the standard works on the subject. This edition, which was published in German in 1910, is on the same lines as the previous one, but is, as might be expected, much expanded and revised to include the results of the large amount of work which has been done in connection with volatile oils during the last decade. Section 1, dealing with the history and development of the volatile oil industry, has naturally suffered the least alteration. Besides a general historical account it includes short paragraphs dealing with the more important individual oils and traces the development of the methods of distillation and apparatus employed from the early days of the industry to the present day.

The second section deals with processes other than distillation which are employed in special cases for the extraction of perfumes, viz. enfleurage and extraction with hot and cold solvents. Explanatory diagrams are included.

The important subject of the constituents found in volatile oils and synthetic perfumes is dealt with in section 3. This section is complete and concise. Details are given of the properties and derivatives of each compound, and of the methods best adapted for their identification.

The last section treats of the general methods adopted for the examination and analysis of volatile oils. Directions for the detection of commonly occurring adulterants are given. Two sets of tables for the calculation of the ester and alcohol contents of oils are included at the end of the book, one bound into the volume and the other, a separate booklet for laboratory use, inserted in a pocket in the back cover.

An unfortunate number of misspellings occur, and the translation in some cases is rather too literal, but defects such as these cannot detract greatly from the usefulness of such a complete and up-to-date treatise. The name of Messrs. Schimmel & Co., under whose auspices the book is published, is a sufficient guarantee of the accuracy and reliability of the information contained in it.

Arbeiten aus dem Pharmazeutischen Institut der Universität Berlin. Vol. X. Edited by Prof. Dr. H. Thoms, Director of the Institute. Pp. viii + 220, Med. 8vo. (Berlin and Vienna: Urban und Schwarzenberg, 1913.)

This volume consists chiefly of the reports on the various investigations in which the Pharmaceutical Institute of Berlin University was engaged during 1912. The work described includes the examination of drugs and secret remedies, researches in organic chemistry, a study of certain microchemical reagents and their application, and the investigation of various technical products derived from the German Colonies. Many of these reports have been

published already in various chemical and pharmaceutical periodicals. The reports indicate that the Institute has a wide sphere of usefulness and that its operations are being maintained at a high level.

The Chemistry of Dyeing. By John K. Wood, D.Sc. Pp. ii + 80, Crown 8vo. (London: Gurney & Jackson, 1913.) Price 1*s.* 6*d.* net; post free, United Kingdom and abroad 1*s.* 9*d.*

This book gives a concise account of the present state of knowledge of the principles of dyeing, and is intended for the use of students who already possess some knowledge of organic and physical chemistry. The work is divided into three sections. The first deals with the chemical composition and general structure of fibres, whilst the second gives a classification of dyes, based on the methods of applying them. In the third section, the various theories which have been put forward to explain the nature of the dyeing process are reviewed, the degree of validity of each is indicated, and it is shown that any satisfactory theory must embrace the two processes of absorption and fixation. A useful bibliography of the subject is appended.

Documents pour l'Étude de la Géo-Botanique Congolaise. Par É. de Wildeman. Extrait du Tome LI du Bulletin de la Société Royale de Botanique de Belgique: 2e Série, T. 1, Volume Jubilaire, 1912. Pp. 404, Imper. 8vo. (Bruxelles: 1913.)

On the occasion of the celebration of the fiftieth anniversary of the founding of the Société Royale de Botanique de Belgique, M. de Wildeman has produced a volume which reviews, in broad features, the present state of knowledge in regard to the flora of the Belgian Congo. His selection of a subject is happy no less on botanical than on national grounds, for the men whose names will always be associated with the botanical exploration of the Congo—Dewèvre, Laurent, and de Wildeman—have worked as prominent members of the Society whose jubilee is celebrated. The work of these and other African botanists has greatly advanced our knowledge of the œcological circumstances of central Africa. The author, however, regards the problems as still far from completely elucidated, and as offering great attractions to new workers. The popular conception of central Africa, and more especially the Congo, as a vast area of dense, virgin forest warranting an almost literal acceptance of the term "Darkest Africa," must give way in face of the results achieved by a more complete exploration of the country. The idea of an impenetrable forest arose from reports of earlier travellers whose journeys into the heart of Africa were made *via* the great rivers which afford

a natural means of approach. The dense gallery forests of the river valleys which constituted the great botanical feature of these pioneer journeys came to be popularly regarded as typical of the whole region, a view that proved wholly inaccurate in the light of journeys made across the general direction of the river courses. It is now well known that the Congo region is not uniformly forested, but presents several distinct types of vegetation, the most important being forest, bush, savannah, and swamp. M. de Wildeman points out that, as in other parts of the world, the main types of vegetation may present different aspects in different regions, a fact clearly recognised by the native peoples not only in Africa but elsewhere. This fact is well illustrated in regard to the "tropical forest" which by the Congo natives is differentiated as "bwange," "sufa," and "pongbo" under varying conditions.

The author's classification (1908) of the Congo region into seven botanical zones is discussed in its relations with Engler's elaborate analysis of the African flora. In their main features, de Wildeman's conclusions appear to receive justification, but the author recognises the advisability of certain modifications—chiefly in the direction of elaboration—and in the revised form his classification provides for two great botanical "provinces," the "Province of the Guinea forest," and "Province of the south and east African steppes." The vegetation of the former is studied in regard to seven "districts," which may be conveniently distinguished under geographical headings, while the latter comprises the associations of certain central African lakes, and the regions of Luapula, Banguelo, and other areas. This classification forms the framework upon which the present volume is built up. The districts are dealt with in eleven chapters, in which discussion of the geographical and botanical features of the area is supplemented by classified lists of the species recorded therefrom. The text is illustrated with numerous photographs, drawings, and maps, several of which are familiar from their appearance in earlier works of the author. Two questions dealt with by M. de Wildeman may be mentioned as possessing an interest which will not be monopolised by professional botanists, viz. the influence of man (black and white) upon the botanical configuration of the country; and the question of the origin of the central African flora. The author is of opinion that man has played an important part in modifying the geographical occurrence of the botanical associations, not only in his rôle as an agent of destruction, but his conscious or unconscious introduction of species "new" to a district. In regard to the origin of the flora, it is pointed out that there is strong indication of a multiple derivation—a contention supported by interesting tabulated evidence.

CEMENT, CONCRETE, AND BRICKS. By Alfred B. Searle. Pp. xi + 412, Demy 8vo. (London: Constable & Co., Ltd., 1913.) Price 10*s.* 6*d.* net; post free, United Kingdom 10*s.* 11*d.*, abroad 11*s.* 5*d.*

In this useful book the author has succeeded in producing a clear, concise, and up-to-date account of the main facts relating to the nature and manufacture of Portland cement, concrete, and bricks.

After a description of the various raw materials for cement, and a short account of the methods of manufacture, the author gives in detail the theories of W. and D. Asch concerning the structural formulæ of clays, and the molecular changes that take place on heating. According to these authors, Portland cement is not a mixture of silicates and aluminates of lime in solid solution, but a mixture of calcium alumino-silicates of highly complex constitution. Graphic formulæ are given, illustrating the constitution of these calcium alumino-silicates, and the changes that take place during the setting and hardening of cement. Methods of testing cements are dealt with in a comprehensive manner, and recent developments in apparatus, such as Nicol's Spissograph, and Schüle's machine for transverse bending tests, are described.

The section on concrete includes descriptions of the nature and proportions of the components used, and the methods of mixing and placing the concrete. Detailed accounts are given of the various systems of reinforcement, and the special properties of concrete with reference to its use as a building material. Emperger's loading test on specially prepared concrete beams is also dealt with.

The author classifies clays for brick-making according to physical characters and not according to chemical composition. The chapter on methods of brick making and burning is comprehensive, and rich in illustrations. Chapters are devoted to the classification of bricks, the manufacture of lime sand bricks, and in the concluding chapter there is a brief account of magnesite, bauxite, and chromite bricks.

The book is well written, practically free from errors and misprints. It is provided with a good index, and can be recommended as a good text-book.

DIE DYSENTERIE: Five popular lectures on its nature, prevention, and self-treatment in the case of Europeans and coloured people in the tropics. By Prof. Dr. Ludwig Külz, Government Physician. Deutsche Tropen-Bibliothek, vol. vii. Pp. v + 64, Demy 8vo. (Hamburg: Fr. W. Thaden, 1913.) Price 2 marks; post free, United Kingdom and abroad, 2*s.* 3*d.*

This is a companion volume to that dealing with malaria and black-water fever, already reviewed in this BULLETIN

(1913, **11**, 696), and it is likely to prove equally useful to residents in the tropics who can read German. The life history of the bacilli and amœbæ that give rise to the two forms of dysentery is clearly described, and excellent advice is given for the prevention of the spread of the disease, including some useful suggestions for preserving the water supply from contagion. The author recommends boiling for ten minutes as the only sure method of obtaining drinking water free from disease germs, preferring it even to the best porcelain filters. Such prolonged boiling is not, however, generally considered necessary, and it is so difficult to get natives or even Europeans to take hygienic precautions that it seems undesirable to make them more stringent than is absolutely imperative.

The directions for self-treatment, and especially those dealing with the important subject of diet, are all that could be desired. The author advises his readers strongly against the use of alcoholic drinks in the tropics, recommending in their place fruit syrups, tea, or cocoa.

The concluding pages deal with the hygiene and medical treatment of natives in the service of Europeans, and include a number of suggestions, the fruit of the author's personal experience, which deserve very careful consideration by the administrators of our tropical colonies and dependencies.

Von der Heydt's Kolonial-Handbuch. Jahrbuch der Deutschen Kolonial- und Uebersee-Unternehmungen. Edited by Franz Mensch and Julius Hellmann. Pp. xlviii +382, 8vo. (Berlin, Leipzig, and Hamburg: Verlag für Börsen- und Finanzliteratur A.-G., 1913.) Price 6 marks; post free, United Kingdom 6*s*. 5*d*., abroad 6*s*. 9*d*.

In this the seventh annual edition of the handbook, the particulars with reference to the various undertakings and public companies in the German oversea possessions have been brought up to date, but the general arrangement is the same as that of previous issues (see this Bulletin, 1909, **7**, 138; 1910, **8**, 102, 437; 1911, **9**, 325; 1912, **10**, 526). The growing interest which is being taken in the German colonies renders the work of increasing value.

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Botanical names and titles of books reviewed are printed in italics.

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